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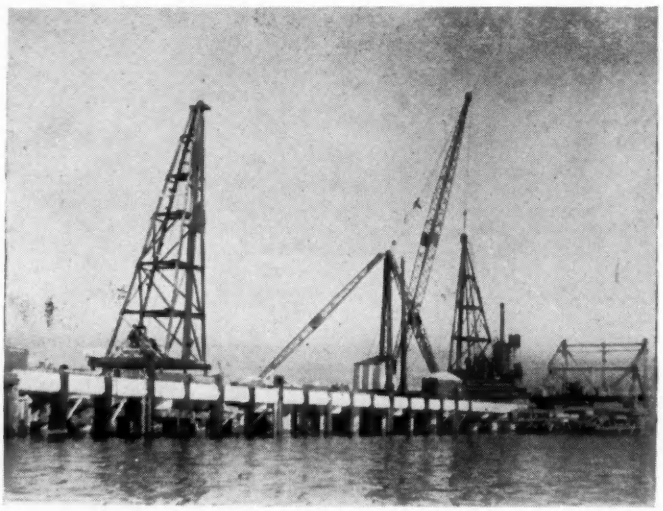

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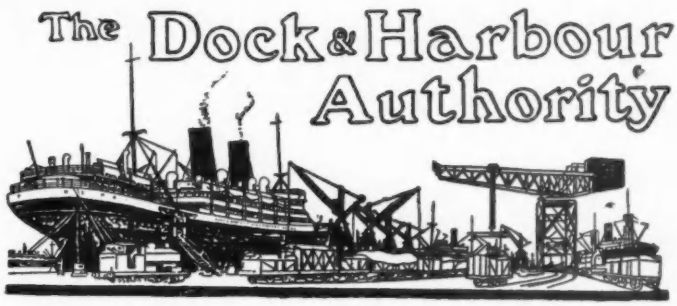

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The Dock and Harbour Authority

No. 359 Vol. XXXI SEPTEMBER, 1950 Monthly 1s. 6d.

Editorial Comments

CANAL LOCKS OF THE NORTHERN REGION AND THE RHONE.

In Europe, inland waterways are, of course, of great importance, particularly in the Netherlands, Belgium, France and Germany, and before the recent war about one-third of the total amount of inland freight traffic of these countries was carried by water. In the Netherlands, the figure was even higher, as more than four-fifths of the total traffic transported by rail and water was moved on the rivers and canals.

The European network of navigable waterways was badly damaged during the war; and the recovery of inland navigation in the post-war period has been necessarily more protracted than that of the railways, and this has been one of the causes, with the exception of the bi-zone of Germany, of increased traffic on the railways and a corresponding decrease on the canals. However, the steps taken to facilitate traffic between the canals of Belgium, Holland and the Rhine, together with the Monnet Plau in France, have set conditions for a greater utilization of inland water transport in the future.

Some details of these co-ordination and reconstruction proposals have been referred to in past issues of this Journal, and in the present number we reproduce part of a paper presented to the International Navigation Congress held last year, which outlines, necessarily very briefly, the proposals and works now in progress for the reconstruction and modernization of the waterways of Northern France. It was manifest at the outset that the dimensions and layout of some of the canals were inadequate; consequently the reconstruction work comprises widenings, new canals, new locks of larger dimensions and, in some cases, locks with small variations in head being replaced by single locks to deal with large differences in water level.

The main object of these improvements is to permit the passage of barges of much larger dimensions, and in certain canals, connecting with Belgium, Paris and Strasbourg, to accommodate barges of 600 and even 1,350 tons, whereas the old French canals were mainly intended for craft not exceeding 300 tons.

The choice of gates and the decision to use sector gates for all locks where the difference in head does not exceed 5 metres, is a subject of some interest. Readers will observe that this type of gate is used not only to close a lock, but also to effect the filling and emptying of it, thereby effecting a saving in construction and operation costs by the elimination of all longitudinal culverts and sluice valves.

The lock planned for the Lower Rhone will be placed on a by-pass of the river, necessitated by the hydro-electric installation of Donzère-Mondragon, and at the time of the Conference a decision had not been made as to the dimensions of this lock, but these were expected to be not less than 90 metres × 12 metres, while the head would be about 25 metres. The speeds of lifting the canal craft will be very high—more than 2 metres per minute—and it is planned to lower the water level, when emptying the lock, by 7 metres per minute.

The use of such high speeds is without precedent, and is only possible because new methods are employed, which, prior to their adoption, had been the subject of exhaustive experiment and trial with reduced scale models. The guiding principles of these are described in the paper, but it is a matter for regret that it was not accompanied by drawings of the arrangements adopted.

In 1946 the Director-General of the European Central Inland Transport Organization, in a lecture (reported in this Journal) at the London School of Economics, stressed the need for full co-ordination in respect to the future organization and control of Continental waterways. Also, in 1949, in an address (similarly reported) dealing with the restrictions on the flow of international transport due, inter alia, to so-called sovereign rights of States, uneconomic routes and services, etc., the President of the Institute of Transport remarked that the ultimate ideal of international co-ordination of transport is that traffic should pass internationally, as if the whole journey took place in one State, and that canal transport could possibly give a lead in this direction.

The projects involved in the reconstruction and modernizing of French inland waterways on the lines described in the Paper, seem to constitute at least a physical contribution to these desirable aspirations.

Since going to press, it has been brought to our notice that there are certain errors in respect to the figure numbers in the article reproduced. We would therefore point out that on page 142, Fig. 1 in the text should read Fig. 2, and on page 143, Fig. 2 in the text should read Fig. 3, these figures referring to each illustration consecutively.

LAMINATED TIMBER STRUCTURES.

At the present time there are few buildings to be seen in Great Britain which make use of the modern glued laminated timber technique. In countries where timber is grown and is normally a standard material for structural purposes, this system of fabricating timber trussed buildings has naturally received a good deal of attention.

On another page we publish an article upon Glued Laminated Timber Structures which, in the nature of a survey on the subject, discusses the advantages of lamination, adhesive requirements, design considerations, early research work in Europe, American progress and fabrication methods, Swedish technique and other aspects of the system.

It will be seen that, owing to the shortage of steel during the war, an appreciable number of buildings of large dimensions using glued laminated arches were constructed in the United States. These appear to have been particularly effective for aircraft hangars and drill halls, where large unrestricted floor spaces are an essential consideration.

Editorial Comments—continued

Research and developments are proceeding on the utilization of the system for bowstring trusses, agricultural buildings, glasshouses and other commercial structures. In this respect, it appears that there may be distinct possibilities for this form of structure in its application to transit and storage sheds in those parts of the world where suitable timber is more readily procurable than steel.

An interesting application is the construction of laminated timber arches to be erected at the Waterloo entrance to the Festival of Britain Exhibition which opens next year. These arches, which have a span of over 100-ft., and a rise of 60-ft., have been manufactured in the United Kingdom, and are the joint gift of the timber trade of British Columbia and the Timber Development Association to the Festival of Britain Authorities.

There is reason to believe that the advantages of laminated timber structures are becoming more widely appreciated, and as the supply position improves, it is probable that we shall see, in the future, its use in an increasing number of commercial buildings.

LITTORAL DRIFT AND COAST EROSION.

The informative article which we publish on page 163 on the Danish West Coast, from the pen of Mr. Per Bruun again brings out in a forcetul way the neccesity of complete and exhaustive investigation into the geodynamic phenomena associated with shore line problems before the heavy expenses of protection works are incurred. The troubles experienced by the Danish Authorities in the attempt to control the fluctuations of the foreshore particularly in those vulnerable localities of the Inlets protected by natural sandy barriers, or spits, present no new problems, and yet it would appear that no effective solution has been found.

In his remarks about the relationship of barometric pressure and the disturbance of sea level Mr. Bruun omits to mention one of the outstanding peculiarities of the North Sea water movements about the West Coast of Denmark. We refer to the fact that the mass water movement as represented by the tidal fluctuations bring about a counter clockwise current system of which the amphidromic point lies approximately on a straight line joining the Lodbjærg Inlet and Hornsea on the Holderness coast of Yorkshire. Some miles off the Danish West Coast and more or less following the direction of the line mentioned above, there is a tidal stream with a set towards the Yorkshire Coast formed by the junction of the waters flowing out of the Heligoland Bight and the waters flowing out of the Skager Rack. This leaves a portion of the Danish Coast from Thyboren to Bukland Huk in a neutral area with a centre about the Lodjærg Inlet. Thus in this region it is probable that the two opposing currents swinging towards the West will provoke local responses and bring about fragile conditions of stability. It is further possible there are two extensive eddies offshore of the inlet—the southerly eddy being clockwise and the northern eddy counter clockwise. The conditions of the beach phenomena as observed seems to point to some operation of this nature and in view of the fact that a very large sum of money is to be spent on beach protection, investigation to this end would be amply justified.

The series of articles on Coast Erosion which we have lately published emphasized the capricious behaviour of sand particularly under conditions of artificial interference, such as effected by high groyne systems. Mr. Bruun's experience seems to confirm the conclusions there adumbrated.

DREDGING IN INLAND WATERS.

In this issue we publish a brief description of a new type of small self-propelled suction dredger which has been primarily built for use in gravel pits, but due to its unusual design, the author of the article suggests it can be used for other purposes, such as the dredging of small rivers and canals, trenched channels and the like.

The special features of the craft are that the units, of welded construction, can be transported to the site and fabricated there by site rivetting, also that the operations of propulsion, dredging and discharging are performed by one prime mover and one gravel pump.

In this country there are many small rivers, the upstream reaches of which are inaccessible owing to mill dams or low bridges, and there are also many long stretches of canals of the narrow class, which are at present restricted. In such cases, where clearance by dredging may be required for flood prevention or navigation, a craft which is capable of being put together at the site and taken apart and removed on completion of the work, appears to be of particular interest.

It is possible that instead of site rivetting some form of assembly, by means of special precision-made rustless joints and the aid of barrel bolts, would be required for easy dismantling, and likewise some form of cutter-suction head might be necessary for dealing with material other than gravel and light silt; moreover the matter of beam, and particularly the draught of the vessel, would need some examination to ensure successful operation in the waterways suggested. In any case, this type of dredger would probably eliminate the use of a fleet of barges and a tug, which normally are required with the usual grab dredger used in accessible waters.

The novel features of this new type of suction dredger, and the principles involved are, we suggest, worthy of the attention of Inland Waterway Executives, Catchment Boards and other Authorities, besides those concerned with the winning of gravel.

COUNTERING THE DEPREDATIONS OF MARINE BORERS.

It is reported from Australia that the Council for Scientific and Industrial Research is believed to have found a deterrent to marine borers. An examination of timbers from many countries revealed that some 500 of them contained silica particles in varying quantities. The Australian turpentine tree was known to possess a high degree of immunity to borer attacks, which it now seems is due to its high content of silica, and other countries have apparently established plantations to provide supplies for their own harbour works. In the course of the studies undertaken in Australia, many timbers were found to have more silica than the turpentine tree, and it is expected that further experiments will show that these will be even more immune to attack.

It is understood that research is also being conducted in an effort to deposit particles of silica in the wood tissues of certain timbers to give this resistance artificially.

Timbers containing natural silica are very difficult to saw, because they rapidly blunt saw teeth, but this difficulty is of small account, if it is conclusively established that the preliminary notions are correct, and that resistance can be effected in a synthetic manner and on a commercial basis.

As is well known, destruction and damage by marine borers cost port authorities throughout the world many millions of pounds every year, and it is therefore to be hoped that these researches will achieve successful results.

CASUAL LABOUR IN PORTS.

The Fourth Report of the International Labour Organisation to the United Nations for the year ended March 1950 has now been published, and the section of particular interest to readers of this Journal, states that an outstanding achievement of the Inland Transport Committee was the adoption of proposals for dealing with the problem of casual labour in ports.

In this connection, the committee annunciated three principles: the need for providing regularity of employment for dock workers; priority in employment for regular workers over casual; and the desirability of establishing systems of engagement which will ensure equitable opportunities of employment for registered dock workers with due regard to the special requirements of the work to be done.

With a view to carrying out these principles, the Committee recommends registration of regular dock workers, arrangements for casual employment during periods of exceptional traffic, coordination of the activities of engagement centres so as to take account of the labour requirements of the port as a whole, central payment of wages, measures concerning stabilisation of earnings, etc. Their Report emphasised that in the regularisation of employment in dock work, close co-operation between the employers and the workers is essential.

There will be general agreement with the concluding sentence of the Report which says, " These proposals represent the most substantial contribution made in the international field to the solution of this difficult economic and social problem."

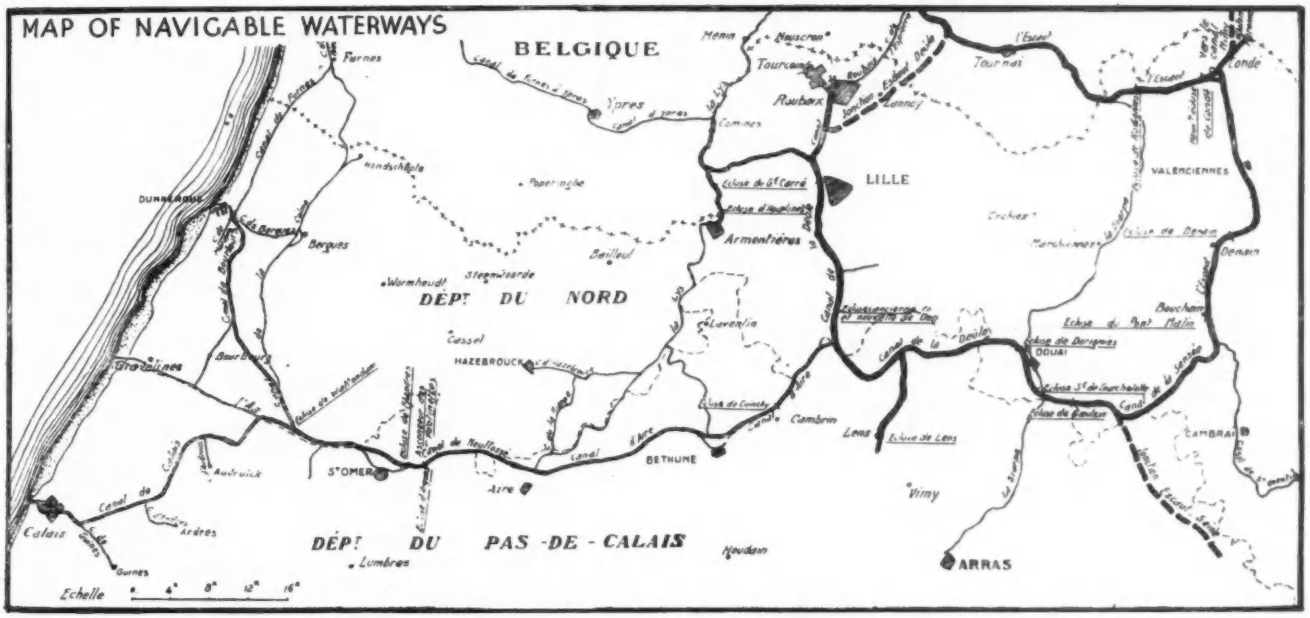
Canal Locks of the Northern Region and the Rhone

Reconstruction and Modernisation of French Inland Waterways*

(Part of the report prepared with the collaboration of M. Fernand Dumas, Engineer in Chief of Bridges and Highways, Regional Director of Navigation at Lille.)

THE network of navigable waterways in Northern France was heavily damaged during the recent war, exceptionally heavy damage being inflicted on them in 1944, both as a result of military operations and of systematic destruction by the resistance movement and by the retreating enemy. Apart from this, the inadequacy of French waterways is such that a simple reconstruction programme cannot be applied.

The main effort of reconstruction has been concentrated on modernising the navigable waterways so that they can permit the passage of barges of large displacement from the mining district of the North and of the Pas de Calais to the region of Lille-Roubaix-Tourcoing-Armentieres, also connecting with branch canals linking up the maritime ports of Calais and Dunkirk with the surrounding district. The use of barges of 600 and even of 1,350 tons displacement has been contemplated for the following routes, namely: between Belgium and Northern France; between Northern France and the Paris district; and linking the north with Metz, Nancy and Strasbourg.



If an increase in the cross section of the canals results in a reduction of the number of locks, there would appear to be ample justification for increasing the size and improving the operating efficiency of the latter. The resulting lowering of the water table will permit many large areas to be drained and rendered healthy (the Lille district and the towns of Bouchain and Denain on the Escaut, and of Lens on the Lens Canal).

In what follows, we shall describe the conditions under which a certain number of locks will be reconstructed, of which five will be in the nature of prototypes. Fig. 1 is a plan of the navigable waterways of the Northern Region, the thickest line representing the waterways which appear to have the best possibilities for development in the future. This plan also shows the positions of various locks, such as the Jeu de Mail in Flanders, the Fontinettes, the Don, the Grand Carre and the Lens, reading from north to south.

(a) JEU DE MAIL LOCK.

As the plan shows, the new Jeu de Mail lock is the first link in the great modern chain of Interior Navigation, destined to connect the port of Dunkirk with the region of Lille. This lock provides for only a slight fall, when account is taken of the lowering of the water table by 30 cms. in the Bourbourg Canal, making the difference in level under normal conditions only 1.73 metres. The lock is of considerable size, and will be 110.25 metres long and 12 metres wide. A pair of intermediate gates divides the lock into two sections, one having a length of 42 metres and the other of 60 metres, the total length being the sum of these two added to a length of 8.25 metres, corresponding to the length of the chamber occupied by the intermediate gates.

The depth of water provided in the lock under normal conditions is about 3.50 metres. The lock of 42 metres length allows the locking of two barges of 280 tons, the only craft of the inland waterway type which can at present reach the port of Dunkirk. The electric tractors employed on the canal usually tow a pair of boats, so that arrangements have been made for the simultaneous locking of the two craft. The 60 metre lock is provided for barges of 600 tons with a length of 50 metres, a beam of 6.60 metres, and drawing 2.50 metres when fully loaded. This large lock provides for the simultaneous locking of a tug and four barges; of two 600 ton barges of the type mentioned above; or of one barge of the largest type. The use of intermediate gates which allows, on one hand, proportioning the area of the lock chamber to the number of craft which can be locked at any one time, supply of water being relatively difficult in the Northern Region, and on the other hand does not unduly increase the time of locking, is a matter of considerable interest.

The depth of water of 3.50 metres is justified by the need to avoid all suction effect at the moment when the craft enter the

*Papers read before the International Navigation Congress, 1949—Section I—Communication I—New developments in the design and construction of locks. By M. Parmentier, Inspecteur Général des Ponts et Chaussées. M. Aubert, et M. Henry, Ingénieurs en Chef des Ponts et Chaussées. M. Dumas, Ingénieur en Chef des Voies Navigables du Nord et du Pas-de-Calais.

Canal Locks of the Northern Region and the Rhone—continued

lock and thus to gain valuable time. A margin of 1 metre for the 600 ton barges is not regarded as excessive in this connection. The arrangement of the lock gates and water control by cylindrical sluice valves and aqueducts of the Jeu de Mail lock do not call for any special comment.

Although this layout provides an excessive thickness of lock walls, in view of the small difference in water level, it was adopted solely on grounds of urgency in development, and because the State reconstruction service was not in a position to carry out the necessary new surveys and tests to make it possible to design a more economical structure of another type. In dealing with a lock for a slight difference of water level, it was not thought necessary to build the lock walls in sections separated by expansion joints. Although the work has been in service for about a year, since February, 1948, this contention has been borne out in practice. The small surface cracks which have appeared are of no importance.

The lock is founded on the fine sand of the Dunkirk region, in which the driving of sheet steel or reinforced concrete piling has necessitated the use of a water jet. This was used principally for the construction of the main cofferdam in steel sheet piling which has been employed to limit the excavation and has been left in place as a permanent part of the structure. Owing to the nature of the soil (a very fine dune sand) and the proximity of a national highway which may suffer from subsidence, the water table was lowered in preference to employing ordinary drainage methods. Thanks to this procedure, throughout the work the angle of repose of the soil was maintained at 45 degrees and in some places the ground was vertical.

Apart from a lightly reinforced girdle, the work has hardly any heavy reinforcement. The coping stones of the lock walls and of the head walls are of free stone—a hard limestone from Bourgogne—because of the difficulty of obtaining granite.

(b) THE FLANDRE LOCK.

The site of this work is at Arques in the Pas-de-Calais, on a branch of the Neuffosse canal, near St. Omer. Since the 5 kilometres of the former canal now reconstructed had two locks, the total difference of level provided for in the new work now under construction will be 3.97 metres under normal conditions and 4.57 metres when the flow of water is a maximum. From the point of view of dimensions in plan, this work is similar to the Jeu de Mail lock.

The lock walls, however, were built in sections with three expansion joints, of which two are in the larger lock chamber, spaced at 17.50 metres from one another, and the third is in the centre of the small lock chamber. Each expansion joint is of trapezoidal form and is simply sealed with tarred rope and asphalt in conformity with the standard technique employed in Belgium and in the Low Countries. It is expected that the new lock will be put into service in the first six months of 1950.

(c) THE DON LOCK.

This lock is situated on an important branch canal which elminates several sharp bends, and replaces two old locks for small craft. As the Deule Canal is not only on the route from Dunkirk to Lille and on that from the Oil Basin to Lille, but also lies on the great future Escaut-Seine navigation route—for which a very important future development is forecast—the dimensions in plan of the two previous works are not sufficient for the purpose.

It is anticipated that there will be a constant traffic of barges having a displacement of 1,350 tons. The lock will be composed of one lock chamber 44.50 metres long, a second of 85 metres length, which, when added to the 8.50 metres of the intermediate lock gate, gives a total useful length of 138 metres. The width of 12 metres is the same as the locks of the Oise in the Paris district, and this has been considered adequate.

Depth of water is 3.50 metres, and the increased dimensions of the lock will enable it to lock six small craft simultaneously, or two barges of 600 tons displacement each. The lock chamber of 85 metres is perfectly suitable for barges of 1,350 tons, these vessels having a length of 80 metres, a beam of 9.50 metres and drawing 2.50 metres of water. When it is necessary to lock a single barge of 600 tons, the consumption of water will evidently be excessive and the speed of locking will be slow. It is therefore intended that in the future a second lock should be constructed to provide the necessary speed of locking.

This second work will have a width of only 7.50 metres. Provided with intermediate lock gates, it will have two lock chambers in tandem, each with a useful length of 55 metres and specially designed to accommodate barges of 600 tons displacement. On the cross section shown in Fig. 1, the actual lock under construction is shown, as well as a dotted outline of the proposed lock for 600 ton barges. Expansion joints of the same type as those in the Flandre lock will be provided in the centre of the small lock chamber, and at the third and two-thirds points on the length of the 85 metre lock chamber.

(d) LOCK OF THE GRAND CARRE AT LILLE.

This lock will soon be constructed on a branch of the Deule Canal near the Citadel of Lille, that is to say, on the same Escaut-Seine route on which the Don Lock is built, and which will serve the Roubaix-Turcoing region and the Comines-Armentiere district, and will replace four locks situated on the Basse-Deule, namely, the locks of Barre and Saint Andrew at Lille, and those of Wambrechies and of Quesnoy further downstream. The difference in water level is 5.97 metres, and similar depth of water will be provided as that in the Don Lock.

(e) THE LENS LOCK.

In order to stop the damage inflicted on the Lens Canal by mining subsidence, the Service of Northern Inland Waterways and of the Pas de Calais are at present engaged on lowering the water table at the second and third reaches of this canal to the level of the Deule, while elminating the two locks at Harnes, and this will entail the reconstruction of the Lens lock, which at present is only suitable for small craft. The new lock will provide for a difference in level of 7.50 metres and will be suitable for barges of 600 tons; it will have a single lock chamber 55 metres long and 7.50 metres wide with a depth of water of 3.50 metres.

(f) FONTINETTES LOCK.

The elimination of the difference of level of 13.13 metres between the two reaches of the Neuffosse Canal (linking the Lys and the Aa) has been provided for by five locks, which are still used during the annual overhaul of the Fontinettes barge lift. This hydraulic lift was put into service in 1885, and was the first of its kind on the Continent. It comprises two compartments each 30.40 metres long and 5.10 metres wide, and accommodates Flemish barges drawing 1.80 metres of water.

Operation of the barge lift depends upon the nearby head of water of 13.13 metres, so that every variation of level in the canal reaches causes operational difficulties, which can even stop the machinery. The lift may also be stopped by a high wind, because of the torsion imposed on the pistons, and also by frost, when special steam pipes have to be provided to keep the mechanism going. An annual overhaul period of from 20 to 30 days is necessary for repair and replacement of mechanical parts subjected to the action of the water, and which are very difficult to grease. The annual cost of maintenance in 1939 was 250,000 francs.

It is to remedy these grave defects on the one hand, and to allow navigation by barges of 2 metres to 2.50 metres draught, that the construction of a new lock for the great difference of level involved is to be put in hand. It will consist of two lock chambers end to end, each with a useful length of 42.60 metres, similar in construction to those of Jeu de Mail and Flandre; the width will be 12 metres and the depth of water 3.50 metres. Three superimposed economy basins will be provided in the lock walls.

ARRANGEMENT OF LOCK GATES AND MEANS OF FILLING

The lock gates, other than those fitted to the Jeu de Mail lock, are of the vertical axis sector type. They are similar to the lock gates of Sodertalje lock, which connects the waters of the Malar

Canal Locks of the Northern Region and the Rhone—continued

lake with the Baltic. This work is situated 40 kms. south of Stockholm and was finished in 1923; it has been described in the report which Captain L. Lawski presented to the Fifteenth International Navigation Congress in Vienna in 1931.

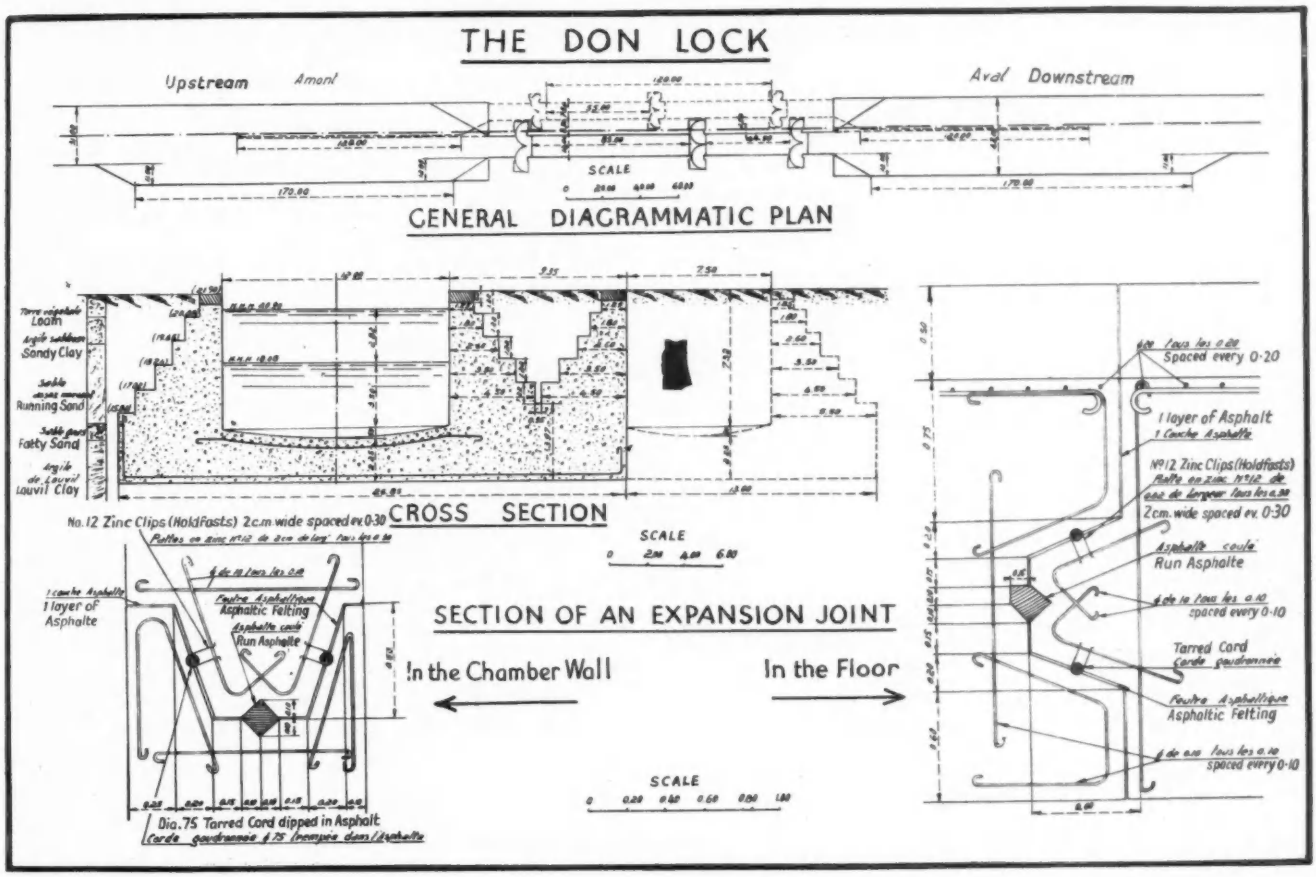
This type of lock gate has been preferred, not only to the usual arched type, but also to the lifting gates already employed in Northern France and which suffer from certain disadvantages, such as the difficulty of operation during frost and the obstruction which such gates offer to towing equipment on the bank.

The benefits resulting from the adoption of sector gates are: the great simplification of refilling the lock and the saving in construction and operational costs by elimination of all longitudinal culverts and sluice valves.

arrangements for opening the gates, and by providing improved types of steadying grilles in the outlet chambers.

(g) OTHER LOCKS.

All the other locks for small craft on the canals now being modernised are shown in Fig. 1, and these will be reconstructed to enable them to deal with barges of large displacement, at the same time eliminating nearby locks. Amongst those which will be tackled in the near future are the following, namely: the Pont Malin lock on the Escaut, which will replace the Neuville lock situated downstream; the Denain lock, which will replace the old locks for small craft at Denain and Haulchin; the Fresnes lock on the Escaut will replace the Antoing lock, which will be superseded by the Belgian Service of Inland Waterways. Locks will also be built at Cuinchy and Wattendam on the Lille-Dunkirk trunk route, and similar works will be carried out at Courchelettes, Dorignies, and Goeulzin in the Douai district; a lock will also be built at Houplines on the Lys. All these locks will be similar to those already described.



The three pairs of gates—upstream, middle and downstream—are identical and their arrangement and that of the gate recesses is such that there is always enough water in the latter to ensure replacement of water lost in the lock due to locking craft.

At the Fontinettes lock, however, an exception will be made to this arrangement, for the great difference in level allows a considerable economy to be effected in the height of the upstream gate. Similarly, in this lock the principle of filling or emptying exclusively by the lock gates has been relinquished, these operations being carried out by means of longitudinal aqueducts with suitable branches.

The arrangement of a sector gate with a radius of 7.20 metres is shown in Fig. 2, a notable feature being the arrangement for ensuring watertightness by means of rubber bags blown up by compressed air. Each gate leaf is moved by an electric capstan.

Model tests were carried out in the particular case of the Flandre lock, from which it was calculated that during filling of the lock, the horizontal forces likely to be imposed on a barge of 1,350 tons would not exceed 2.50 tons. It is hoped that this result will be further improved by appropriate modifications in the

THE SAINT PIERRE LOCK

(Report of M. Henry, Director of Research of the National Company of the Rhone.)

About twelve months ago the works connected with the waterfall on the Rhone between Viviers and Modragon were put in hand; on this reach of 40 kilometres the difference of water level varies between 22.50 metres and 27.85 metres, according to the rate of flow. The works comprise the following, namely: an impounding dam at Donzere, which maintains the water at a level of 58 metres above sea level, a navigable entrance canal of 17 kilometres and a similar canal for discharge of 11 kilometres length, both designed to take a maximum flow of 1,500 cubic metres a second at an average velocity of 1.30 metres a second.

Canal Locks of the Northern Region and the Rhone—continued

These works provide a head varying from 16.30 to 24.95 metres, according to the state of the river bed downstream. It is intended to deepen the river at this point, and the Company can limit this deepening to 1 metre if the head does not exceed 25.95 metres. This report describes works involving an upstream still water basin, which forms a branch of the entrance canal, and the Saint Pierre lock of 90 metres useful length and 12 metres wide, which will later be duplicated by a lock 230 metres long and 22 metres wide. The third work is a downstream basin which connects with the discharge canal.

The upstream level can vary between 58 metres and 56.30 metres, the level of the bottom of the basin being at 53 metres, which provides a minimum depth of water of 3.30 metres. The authorised draught being 2 metres, the margin of 1 metre 30 cms. is one metre more than the 30 cms. which are laid down as being essential in every case. This addition of a metre allows for wave action and for silting up between successive dredgings.

Special precautions have been taken to avoid variations in the operation of the power station from causing dangerous waves. Each hydro-electric generating group will be provided with a liquid resistance capable of being connected in parallel to the transformer. On taking up load, the group will be connected to the resistance and its output will be able to increase as gradually as may be desired. The reverse process will be followed when power is being shut off. If the shut-down is unexpected, the group will be automatically controlled by the liquid resistance, thus eliminating all variation of output.

The proportion of the flow from the Rhone into the canal is regulated by the opening of the valves at the intake dam, and the flow in the canal can then be directed to the power station or to the discharge valve. In short, the liquid resistances will permit variation in output of groups similar to the flow through the discharge valve, thus avoiding the repercussions caused by violent changes in the power supplied to the system.

The upstream basin has been specially designed to deal with towed convoys. Convoys arriving at high speed in the entrance canal will require a length of 650 metres in which to be stopped, the braking being done by means of fixed bollards. Barges are moved to the lock by a number of capstans, the tugs proceeding to a turning basin which has a diameter of 90 metres; at the lock entrance a pair of capstans enables each barge to be positioned for locking. The downstream basin has similar arrangements, but this basin is very much shorter and the convoys arrive at very slow speed.

The design of the upstream and downstream basins was studied by means of a scale model in the Dauphinois Hydraulic Laboratory at Grenoble, with the object of avoiding dangerous side currents at the entrance of each basin, so that the continuous renewal of the water in these basins will not cause a current likely to be a danger to navigation.

Scale model investigations were also carried out at the same laboratory on the problems of filling and emptying the lock, employing the conclusions reached by researches undertaken over a period of fifteen years in the United States, notably in the Laboratory of the University of Iowa by Mr. Martin Nelson. Rapid filling causes a heavy discharge because the average upward velocity is 3.50 metres per minute, the maximum velocity reaching 5 metres per minute, corresponding on a water surface of 1,272 square metres to a discharge of 106 cubic metres a second. When filling has been completed, this discharge is halved, but the head can reach as much as 26 metres.

The problem is to dissipate this power, which is of the order of 32,000 horsepower, without causing a general current in the reach, nor heavy turbulence which will damage craft, nor a dangerous swell. In hydro-electric projects, energy can be dissipated by a given head. The present problem is more complicated, the head being a maximum when the volume of water for dissipating the energy is at a minimum.

An unsymmetrical arrangement for the supply of water means that the water will build up on one side of the lock. The difference of level thus created can reach 60 cms., and this has been experienced in the locks of the Welland Canal with an average vertical water velocity of 2.80 metres a minute. This difference of level causes a longitudinal ebb, so that during locking the vessel is subjected to heavy pressure, so that the mooring ropes may break and the vessel thrown against the lock wall on the downstream side.

With longitudinal aqueducts supplied from upstream, the wave produced by opening the valves is not instantly propagated, because the inlet sluices discharge successively. This happens in locks of conventional type in which the discharge is considerable, for example, at Kembs, where the average vertical water velocity is 1.50 metres a minute. The surface of the water is disturbed by turbulence at each pair of inlet sluices successively, whereas the downstream end of the lock is still perfectly calm.

If the current produced is not too strong, the ebb can be throttled by making the water rise very quickly; the moment of inertia of the pendulum to which we can compare the mass of water in oscillation, and its natural period, thus increase rapidly so that the oscillations produced by initial lack of symmetry die down progressively. It is somewhat analogous to what is observed in a cableway: when the load is raised and the driver stops its travel, the load oscillates like a pendulum and the dying down of the oscillations is very feeble. If the driver lets out the clutch and allows the load to descend freely at full speed at the same time as he stops its travel, oscillation practically disappears. The best means of preventing a current from being produced in a lock is to arrange for symmetrical supply of water.

However, whether a lock be supplied through a vertical conduit discharging into the centre of the lock chamber, or through two horizontal conduits discharging opposite one another also in the centre of the lock, neither of these two methods will be acceptable; both will produce a strong swell in the centre of the lock, such as that which occurs at the discharge downstream from locks on the Tennessee at Fort London and Chickamauga. In the latter case, the downstream outlet is situated in the downstream reach, and on one occasion a vessel was lying here at the moment of discharge; she was caught by the current and her crew were not able to control her until she had travelled about a kilometre.

It is therefore necessary for the water supply to be not only symmetrical, but also distributed over the length of the lock, or better still, over its surface. The water surface will be horizontal but very agitated, and such movement will not perhaps be important for large vessels, but it cannot be permitted for small craft, notably for the dinghy which every Rhone barge tows astern.

There are two means of eliminating this surface movement of the water. The jets issuing from the inlet sluices in the bottom of the lock cause turbulence below a certain level, disappearing when the lock is sufficiently full. Above this level, water movement is an entirely vertical translation. That is why with all systems difficulties are caused at the start of filling; the depth being sufficient to ensure that turbulence will die down as soon as the velocity of filling is increased. Conversely, there is no surface agitation as soon as the water level is high enough for turbulence to disappear. This means that the lock chamber should be given considerable extra depth, the inlet sluices discharging at the bottom of the lock chamber. It is for this reason that the U.S. Army Engineers have given a depth of 3 metres to the lock of Keokuk on the Mississippi. This solution is expensive and should be employed with moderation.

Another method for reducing the time of the dying down of the jets is to arrange for the water velocity to be very low when the jets enter the lock chamber. The water should be taken to the lock chamber through conduits designed to avoid practically all loss of head, after the fashion of a penstock leading to a water turbine.

The condition to be fulfilled during emptying are very much simpler, in that there is no need to arrange for the dying down of energy; it will suffice to arrange for symmetrical emptying over the surface area of the lock.

Finally, it is necessary to eliminate all reaction of filling and emptying in the upstream and downstream basins. This is an easy matter in the case of hydro-electric power schemes. In the case of the Saint Pierre lock, the lock chamber has been deepened by 2.50 metres. Water supply is derived from an intake at the

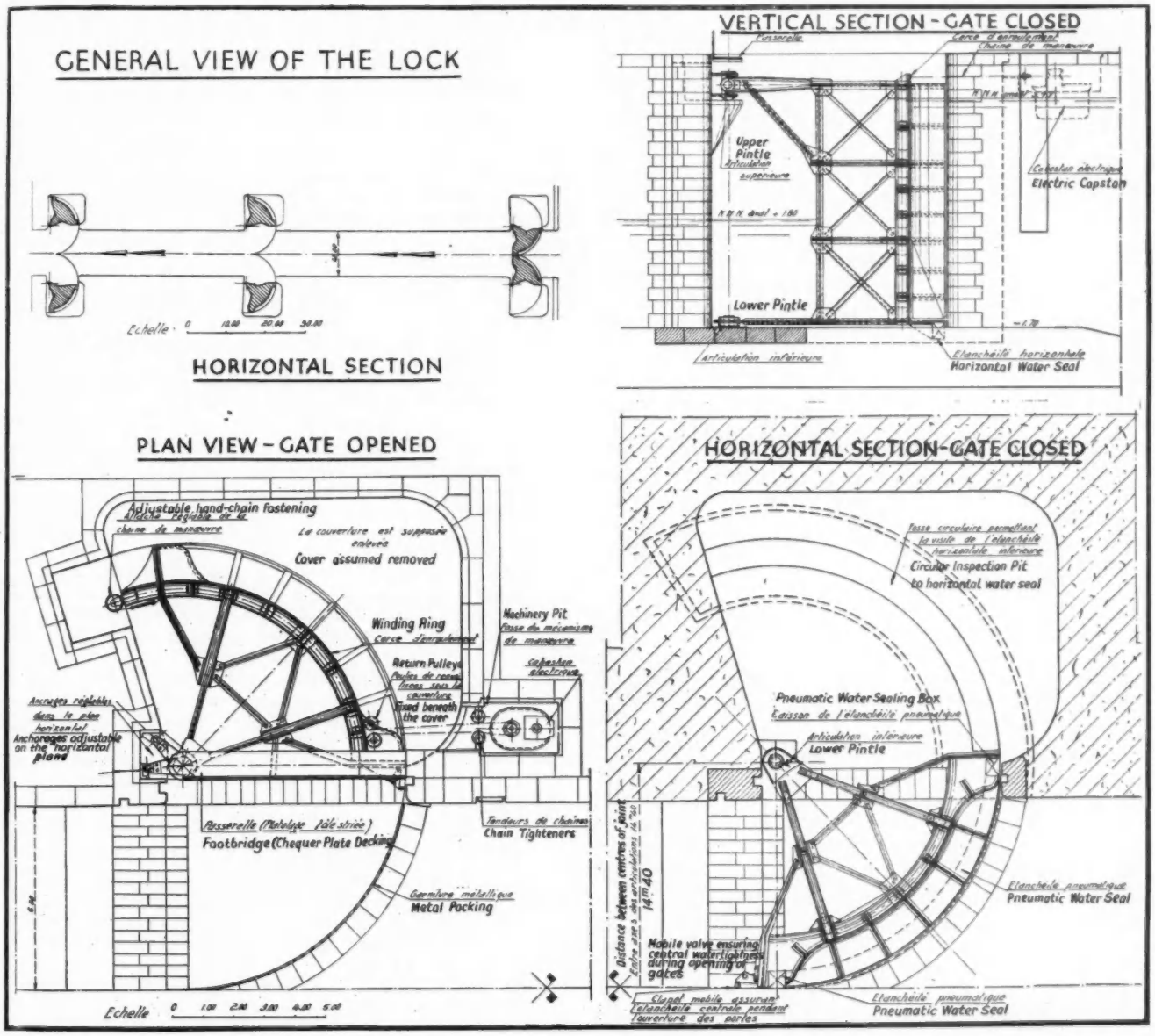
Canal Locks of the Northern Region and the Rhone—continued

power station, with two valves discharging freely into a pressure conduit which has several bends and joins into a transverse conduit; each half of the lock is supplied through a conduit of variable rectangular cross section with cross connections.

Distribution of water over the entire area of the lock being thus assured, two variants of the type of cover on the transverse conduits have been studied. The first is a cover of dihedral form providing two vertical triangular openings. The second is a bottom cover, which owes its practical development to M. Caquot, comprising a flat plate provided with round holes, an arrangement often adopted for stilling basins.

Drainage is easy with an average velocity of 5 metres a minute.

The Company has adopted a system of gates made by Messrs. Schmid, Brunneton and Morin, in consultation with M. Caquot. The two gates operate vertically; the downstream gate is a lifting type, the upstream sluice is the lowering type and opens as it descends. There is thus no external superstructure with winches and there is no need to enlarge the lock walls so that the gates can open, as is necessary with curved gates. Each gate has rollers and, under water pressure, it rests on sills, so that the rollers then carry no load, as in the case of ordinary gates. Each roller is mounted eccentrically on a torsion bar forming a spring. The



The two variants lead to a balance about equal to the power; 95 per cent. of the head is consumed in losses upstream of the lock chamber, the remaining 5 per cent. being dissipated in turbulence which only disturbs the surface of the water to a very slight degree, the average velocity of the water being 3.50 metres per minute. To the eye, the triangular conduit appeared to give best results, but when a cinema film was taken under lamplight of the model, the perforated plate gave a better effect.

For emptying, a similar arrangement is used and the water is discharged by two valves on the same axis as the supply valves.

gate therefore bears on the sill as soon as the resultant pressure of the water slightly exceeds that provided for by the springs. This last force is at least equal to the pressure head, due to a difference of level of 30 cms., increased by the frictional resistance of the sills. Opening of the gate is thus possible as soon as the difference of water level has been reduced to 30 cms., which means that it is not necessary to achieve complete levelling of the water on both sides.

The gates are circular and their concave surfaces face the lock chamber, the useful dimensions of which are thereby increased.

Canal Locks of the Northern Region and the Rhone—continued

The upstream gate has about the same weight as a conventional curved gate, while the downstream gate weighs very much less.

With the rising and falling speeds of the water in the lock, which have been envisaged, it has been necessary to prevent any craft from being moored to any fixed point. At the maximum downward velocity of 7 metres a minute, the surface of the water descends one metre in 8.5 seconds. This means that there would not be time avoid difficulty if a craft were moored at one side. Therefore, on each lock wall four floating bollards have been provided, of a type similar to those used in France at Amfreville and in the United States for high-lift locks, the four extreme bollards being provided with capstans. On each dock wall, an endless cable is turned around two of the capstans, of which one is driven and the other acts as a brake, which provides for a tension in the mooring cable of about 2,400 kgs. Pulled by an outer capstan, a craft enters the lock and is stopped by the floating bollards; if the position of the vessel has to be altered, the cables of the floating capstan bollards can be used for this purpose.

For rising or descending craft, it is not yet known if the floating bollards are necessary, and experience will show the manner in which these will operate. When leaving the lock, the barge-hand makes fast a cable at the stern of the vessel, which is thereby pushed out of the lock so that she can reach the side of the upstream or downstream basin, where capstans are fixed for further manœuvres. Such at least are the arrangements which have been made to ensure flow of the present traffic, but if the traffic increases the Company will provide a small tug at the lock.

As in the case of American high-lift locks, vertical fenders are anchored in the lock walls to prevent the craft from being damaged.

The company propose to adopt mass concrete construction for the lock, because the latter will form an integral part of the hydro-electric power station. Heavy mass concrete has been adopted not only for this reason, but also because it is desired to simplify shuttering, the price of additional concrete being very low. In short, a mass concrete structure needs less labour, which is important because of its very high cost. The structure will be divided into sections by expansion joints spaced at 14 metres centres.

When the survey of the Saint Pierre lock was started, it appeared that this would be the highest lock in the world; but the Nory lock on the Columbia River, in the United States, which was begun in August, 1948, will have a maximum head of 27.60 metres, with a time of filling corresponding to an average velocity of 2 metres a minute, which it is believed will be exceeded at Saint Pierre.

CONCLUSION

The authors have confined themselves to those points which they consider to be interesting or novel. As far as the construction of the lock walls of high-lift locks is concerned, one of the most important points in their opinion is that it is sometimes an advantage to reinforce the upper part of the walls by reinforced concrete vaults. Their presence would avoid alternating loads on the soil below the foundation, which results from filling and emptying of the lock chamber. Instead of consisting of two more or less independent lock walls, the lock will take the form of a grooved monolith.

It is interesting to note that in Northern France, as well as on the Rhone, a lock width of 12 metres has been adopted, which appears to conform very well with modern inland water transport needs. In the two cases quoted, extensive use has been made of scale models, which have been very instructive. The experiments have confirmed that the phenomena attending filling a lock can be most usefully reproduced on a small scale.

Ship Delays in Port

High Sea Speeds nullified by Slow Cargo Handling

By R. LOWERY, M.I.N.A., M.Soc.N.A.
Naval Architect and Assistant General Manager, Canadian Vickers Limited, Montreal.

Almost without exception, modern ships have operating sea speeds much higher than those which would have been considered satisfactory some years ago.

To a great extent, this is because higher speeds are " fashionable " and, therefore helpful in securing cargoes, which in many cases, could actually be transported satisfactory at much lower speeds.

Some ships are running at speeds much too high for their trading conditions, but on the other hand many older ships cannot be operated economically because their service speeds are too low.

The correct economic speed for a ship is that which gives the best balance between many variables, including, on the expenditure side, capital cost depreciation, interest, insurance, repairs and maintenance, management, brokerage, port dues, loading and discharging costs, wages, victualling, stores and fuel; and on the income side, by the earnings from cargo carried in the period being considered. Costs whilst actually running at sea include wages, leave allowances, victualling, stores, fuel, etc., and with the exception of fuel, as the sea speed is increased all these costs are lowered per ton of cargo carried per year, since the running time at sea is decreased.

Increase in sea speed, however, because it reduces the actual time spent at sea, increases the relative time spent in port to time spent at sea. This quite natural increase in the ratio of time in port to time at sea, is however, being greatly aggravated by ships actually having to spend longer times in port than hitherto, and it is probably safe to say that excessive time in port is the greatest single operating problem shipowners have today.

Investigation has shown that whilst in pre-war years it could be said that an average ship spent about two hundred days at sea and one hundred and sixty-five days in port, the present average is about one hundred and fifty days at sea and two hundred and fifteen days in port.

This fact, alone, means that an increase of some thirty-three per cent. in sea speed will only allow a modern ship to carry the same amount of cargo annually as that possible in pre-war years.

Despite the great efforts in the cause of progress by naval architects, marine engineers and shipowners, the time saved at sea, achieved at considerable expense, is being completely nullified by the increased time spent in port; and in many instances, due to this fact the fast modern vessel is not transporting as much cargo annually as did its slower, pre-war sister. This is a ridiculous state of affairs which should not be tolerated, but which can evidently only be overcome by concerted, organised, International effort on the part of shipowners, naval architects, port authorities, labour organisations and, possibly, government authorities themselves.

ECONOMICS OF SHIP OPERATION

The writer believes that despite considerable recent publicity given to this matter it is not always appreciated how vitally additional days spent in port seriously affect economic operations, or how much more important the problem is when sea speeds are high than when they were low.

A fifteen knot ship, crossing the Atlantic, saves only two days over a twelve knot ship, but all things being equal will take the same length of time to load and discharge cargo whilst in port.

The following table shows the effect which additional days spent in port have upon a 16 knot ship trading between terminal ports 2,000 miles apart and having cargo gear, etc., which should allow a normal turn around period of four days.

Additional days in port each visit	Sea speed which would carry the same cargo annually if only four days were spent in port
0	16 knots
1	13.4 knots
2	11.6 knots
3	10.1 knots

Ship Delays in Port—continued

Assuming other conditions the same but a vessel on a trade having 5,000 miles between terminal ports, the corresponding figures become as undernoted:

Additional days in port each visit	Sea speed which would carry the same cargo annually if only four days were spent in port
0	16 knots
1	14.9 knots
2	14 knots
3	13.1 knots
4	12.3 knots

From the above tables, the astounding fact emerges that one additional day lost in port reduces the effective cargo carrying advantages to the owner of a 16 knot ship to that of a vessel one or two and a half knots slower, which slower vessel would, of course, have lower capital cost.

Naval architects and marine engineers, with the active co-operation of shipowners, have, since the advent of power propulsion, fought an increasing and relentless war against high fuel consumption. So much has been done and recorded regarding such efforts, that fuel economy is more frequently quoted than any other basis as an overall indication of increased ship efficiency.

It is contended by the writer, that in this respect, we appear to have lost our sense of perspective. Better hull forms and propellers, reduced lightweight due to welding and great improvements in propelling machinery, have all improved deadweight ratios, and reduced the cost of speed in relation to other actual running costs, to the stage where fuel consumption is probably less important now than ever before. The fuel bill for modern ships is usually between five and ten per cent. of the total actual operating expense (i.e., total expense less depreciation, interest, insurance, management, etc.), whilst between forty and fifty-five per cent. is normally taken by port charges and cargo handling costs. If, to these, we add the expenses (such as wages, victualling, stores, etc.) accruing whilst in port, the total expenditure in port will generally be found to vary between fifty-five and seventy per cent. of the total operating expenses. These figures are, of course, subject to considerable variation due to flag, service, etc., but they are believed to be sufficiently close to demonstrate the point under review.

IMPROVEMENT IN TURNAROUND SPEED ESSENTIAL

The percentages quoted, indicate that to reduce time in port, port charges and handling costs by only five per cent. will have as much effect upon operating costs as some phenomenal achievement such as halving fuel consumption. This alone should emphasize the absolute necessity for improvement in turnaround speed and reduced costs whilst in port, if progress in ship design is to be made and if ship operation is to be conducted on a reasonably sound business basis.

The effect which ship designers can have in reduction of time and expense in port is valuable, but somewhat limited, and at present, would only help to recover time which has already been needlessly lost since the pre-war years.

This giving away of time in port has undoubtedly been largely contributory to the relative lack of attention given to cargo handling equipment and arrangements by ship designers and shipowners.

This is, however, no fundamental reason why the whole problem cannot be pursued with the same vigour as have other no more complex problems which stood in the way of progress.

RESTRICTIVE PRACTICES INCREASE HANDLING COSTS

Principal factors influencing port speed, insofar as the ship itself is concerned, are stevedoring, port facilities and cargo handling arrangements, and since port facilities and cargo handling arrangements are at least as good now as they ever were, it appears quite evident from the longer times now spent in port that the factor requiring the most attention is stevedoring.

Stevedores, today, are just as skilled in their art as ever before, yet even with improved cargo gear they are not, in general, handling cargoes at as good a rate or as economically as previously, due to many causes, including severe restrictions on size and weight of lift, increased numbers of men per gang and high overtime and special rate demands, which have virtually killed overtime or night operations. Some of these stevedoring restrictions are, no doubt, necessary and advisable but it is evident that they have in many instances, gone much further than is really necessary.

In considering port facilities, it must be admitted that in many ports equipment is very poor and, in some, accommodation is so inadequate that during periods of high port activity numbers of ships must wait days in order to get a berth; an ironic touch being, of course, that eighteen knot ships wait just as long as those of ten knots. Even when the ship gets alongside the berth, the storage and handling arrangements are frequently inadequate or require considerable improvement.

Analysis of cargo handling operation in most ports appears to show that, at present, although poor piers, badly designed and located warehouses, inadequate approaches, etc., greatly add to the time of handling cargo whilst it is on shore and to the overall cost of cargo handling, nevertheless most ports are capable of supplying cargo to, or taking cargo from ships at a greater rate than the average ship demands. It appears that the basic improvements which are required first would save little time in loading and discharging ships but would, on the other hand, save considerable cost and time in handling the cargo whilst ashore to, in and from the warehouses. Later, when the design of ships and their cargo gear are improved, assuming stevedoring does not further deteriorate, the bottleneck will probably move to the pier, but at present, neglecting the stevedoring problem, from the point of view of speed of cargo handling as affecting time in port, it is ship design and ship cargo handling gear that appears to need special attention.

Physical factors influencing speed of handling cargo by a ship, include:

(a) Type and method of working cargo gear.
(b) Quantity and speed of gear in relation to cargo to be handled.
(c) Dimensions, shape and disposition of cargo spaces.
(d) Size and disposition of hatches, side ports, etc.
(e) Hatch covers, types and handling arrangements.

SUGGESTIONS FOR IMPROVEMENT IN SHIP WORKING

There is insufficient space in this brief review to do more than touch upon some of the more important factors in this connection and, naturally, each particular service requires special thought and attention. The principal factors appear to be:

(1) More attention should be paid to obviating any ship having a slow hatch by having a poor combination of cargo space capacity and single or double handled hatches and, in general, it is suggested that any hatch serving more than 75,000 cubic feet should be double handled.

Much time is lost due to the inability of present cargo gear to put the hook directly over all items of cargo to be lifted and every consideration must be given to improving this condition by modifying the type of gear or by the introduction of larger hatches either on the centreline or port and starboard, and by serious consideration to more frequent fitting of engines aft in order that cargo can be carried in that portion of the ship best suited for cargo carrying.

Girders above deck and few wide spaced, but smooth pillars, flush steel decks and low coamings with sloping ramps would also do much to improve cargo handling on the ship.

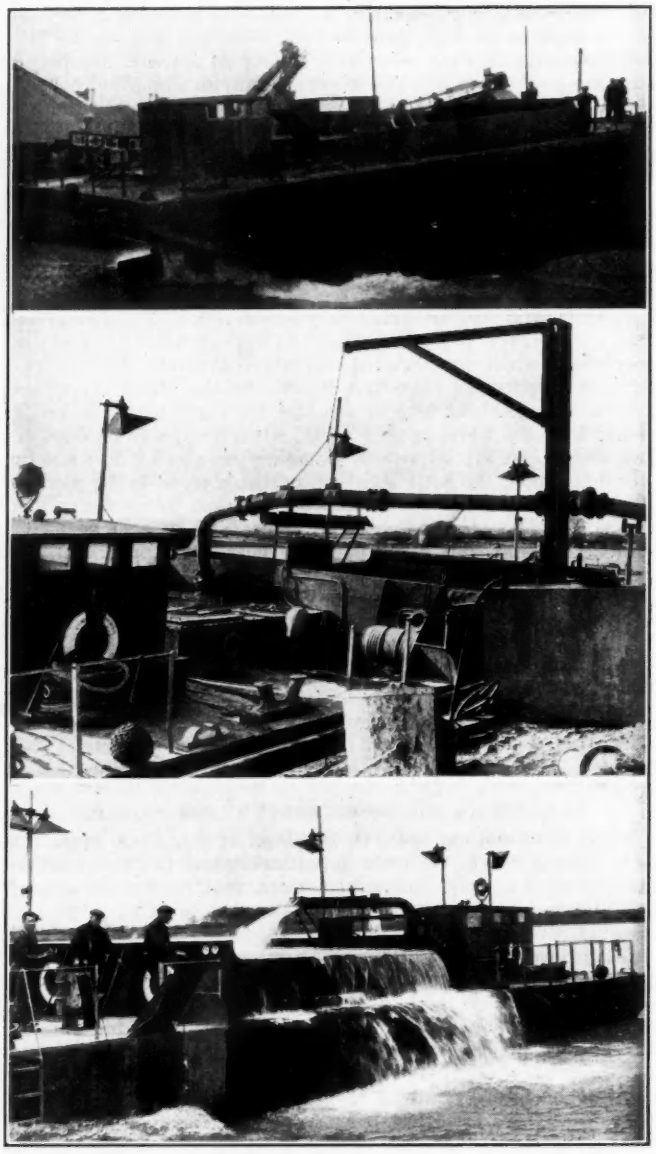
Booms are almost invariably topped and fit in port nowadays, and the provision of topping winches would do much to simplify and speed up this operation.

It has been calculated that at least ten per cent. of the time spent in port is occupied in opening and closing hatch covers, without taking into account additional time lost due to inclement weather, and the provision of modern steel watertight mechanical hatch covers require serious consideration for the benefits they offer in this connection.

Dredging in Inland Waters

New Type of Small Self-Propelled Suction Dredger

A new type of self-propelled suction dredger for winning gravel in wet pits has been designed and built by Brooke Marine, Ltd., of Oulton Broad, Lowestoft, to the order of Dow-Mac (Quarries), Ltd., Tallington, Stamford, Lincs. This type of dredger is also



TOP: Launching of Dredger.
CENTRE: Dredger tied up at Quayside and connected up to land connection pipe leading to gravel plant.
BOTTOM: Dredger Loading Gravel.

useful for dredging small rivers and canals, trenched channels and the like, where silt and similar material has to be removed. It would not be suitable where hard clay is encountered.

The outstanding features of the design are that the operations of dredging and discharging are performed with one prime mover and one gravel pump, and that the vessel is built of steel and prefabricated in welded units at the builder's yard, each unit being of maximum practicable size and weight for transport by road and assembly at the site. There are eight such units, none of which exceeds 5 tons in weight, and these are rivetted together at the site where the dredger is to work. The hull is of box form, divided into four watertight compartments with scow ends, and the hopper is of the inverted pyramid type.

METHOD OF WORKING

In operation the dredger is capable of filling and discharging its hopper six times in a 24-hour day. The hopper is designed to carry a maximum of 130 cu. yds. of gravel weighing 34 cwts. in wet condition. The total output of the dredger is therefore 1,320 tons or 780 cu. yds. per day, though this output is naturally dependant upon the length of run between the points of loading and the point of discharge, the above figures relating to a round trip of about ½-mile.

The gravel is drawn, by the centrifugal pump, from the bottom of the pit, through a suction pipe, and is discharged into the hopper. This pipe can be moved up and down to provide for various depths.

The fore and aft ends of the hopper are made higher than the sides so that excess water can run off overboard when the load level is reached. When loaded, the dredger proceeds under its own power to the discharging quay, where the delivery pipe is coupled to the shore connection and, after operation of the necessary valves, the gravel pump draws the load from the bottom of the hopper and discharges it through a rising main to the gravel screens on shore.

PROPULSION AND STEERING ARRANGEMENT

The prime mover is a Diesel engine with an output of 100 B.H.P. at 1,000 r.p.m. This is connected through dog clutches and a marine-type gear box giving ahead and astern motion, so that power can either be applied to the propeller shaft for moving the vessel to and from the point of loading, or to gravel pump for loading or discharging the hopper.

The engine room casing is arranged with a portable top so that machinery can be removed as a complete unit. A 200 v. D.C. generator, driven by a separate auxiliary engine, is situated in the engine room to provide power for floodlights, deck and service lights so that the dredger can be operated at night.

Hand steering is fitted, comprising a pedestal with wheel connected to the rudder by chains and sheaves. The rudder is of the semi-balanced type. Hand-operated combined mooring and anchor capstans are fitted at each end of the vessel. Two 200 lb. Danforth anchors are provided, each attached to 50 fathoms of ⅝-in. short link cable. Six cast iron double type mooring bollards are fitted in suitable positions on the deck, and a hand-operated winch is situated in the appropriate place for raising and lowering the suction pipe.

PUMPING ARRANGEMENT

Fitted in each watertight compartment are 2-in. suction deck discharge hand bilge pumps, whilst power suction is also provided for each compartment. The bottom of the hull is suitably cemented and drain wells are provided at each suction position.

The main gravel pump is an 8-in. diameter centrifugal pump of the single inlet, vertical split type, made by Gwynnes Pumps, Ltd. Its capacity is about 140 tons per hour of solid material at 25% solids by volume. A 2-in. diameter centrifugal pump of the "Comet" type, also supplied by Gwynnes Pumps, Ltd., supplies flushing water to the main pump at the rate of 100 gallons of water per minute against a total head of 100 feet.

The main pump can take suction through 8-in. diameter piping from either the floor of the gravel pit or the bottom of the hopper, suitable sluice valves being provided. The piping external to the barge for sucking from the gravel pit is fitted with a length of flexible rubber pipe, and with a dredging mouth at one end and a special trunnion mounting at the other, where it passes into the barge. This external piping can be raised and lowered by a hand operated winch. The pump can discharge either into the hopper or into a shore discharge line, a ball-type revolving joint and special quick-operating flange type coupling being fitted to enable a rapid change-over to be made.

The dredger is 82-ft. in length overall, with a breadth moulded of 23-ft. and a depth moulded of 11-ft. 6-in. The loaded draft is approximately 9-ft. Accommodation for the dredging master is provided in the forepeak, comprising a bunk, cooking arrangements and a coal-fired heating stove.

Oil Handling at Ports

Some Developments in Continental Practice

(By a Continental Correspondent)

(concluded from page 125)

Last month our correspondent dealt with the heavy increase in world oil consumption, types of oil ports and their siting, transport of oil inland, together with some examples of French oil depôts. In this concluding instalment he reviews certain aspects of Continental practice in respect to the layout of oil wharves and pipe lines, and gives some examples of tanker moorings.

LAYOUT OF OIL WHARVES AND PIPE INSTALLATIONS

In Fig. 5 we have three different arrangements of wharf for tankers of 22,500 tons; in Type A the pipelines occupy a width of about 7.50 metres and the width of the approach jetty is about 4 metres. In Type B one of the jetties takes the pipelines and the other one deals with road traffic, in which case the wharf should be long enough to allow for easy flow of vehicles. A one-way passage could be arranged for all vehicles over the two jetties, but the lorries must be at a safe distance from the flexible pipes during unloading operations; it will not generally be practicable to arrange for a work which is large enough to provide for this facility.

It therefore seems preferable to concentrate on a layout which will provide for one or two approach roads about 3 metres wide. Type C is probably the best of these three designs, and the jetty should be wide enough to provide for the accommodation of two sets of pipes and an approach road 3 metres wide.

The number, diameter and layout of the pipelines and cables at a wharf will vary according to local conditions, but in certain cases a wharf used for the discharge of crude oil may be occasionally used for handling white oils. Space reserved for pipelines should be easily accessible and of ample dimensions; it is desirable to have short lengths of pipe even in spite of the inconvenience arising from having a large number of joints, one every 30 or 40 feet on the average, because such an arrangement facilitates maintenance and repair.

The servicing of ocean going tankers demands considerable care in the planning and layout of the piping installation, and a cross section showing one of the proposed oil wharves at Le Havre and the arrangement of piping is shown in Fig. 6. Fresh water must be supplied to satisfy the needs of steam tankers at the rate of 500 tons a day at each wharf, and there must be additional boiler and diesel oil available for both steam and motor tankers at a minimum rate of 250 tons an hour. Steam must also be available for supplying tankers during loading operations and to cover any emergency which might arise.

At the Port of Le Havre, the following pipe sizes are recommended for oil handling:

MAIN PIPELINES.

Pipelines for heavy crude oil which must be heated by an internal steam pipe. 3 pipes of 12 inches diameter.

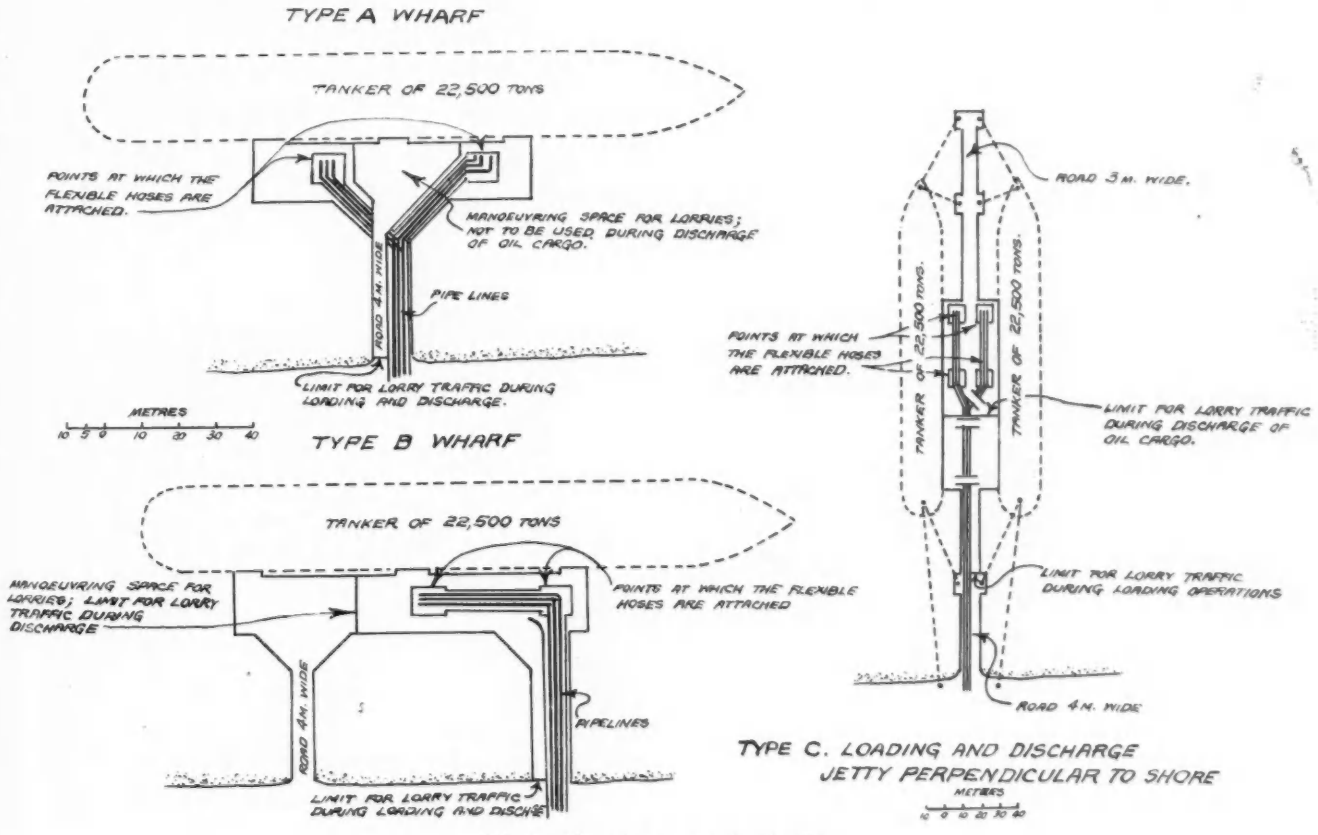

TYPE A WHARF
TANKER OF 22,500 TONS
POINTS AT WHICH THE FLEXIBLE HOSES ARE ATTACHED.
MANOEUVRING SPACE FOR LORRIES; NOT TO BE USED DURING DISCHARGE OF OIL CARGO.
ROAD 4 M. WIDE
PIPE LINES
LIMIT FOR LORRY TRAFFIC DURING LOADING AND DISCHARGE.
METRES
TYPE B WHARF
TANKER OF 22,500 TONS
MANOEUVRING SPACE FOR LORRIES; LIMIT FOR LORRY TRAFFIC DURING DISCHARGE
POINTS AT WHICH THE FLEXIBLE HOSES ARE ATTACHED
ROAD 4 M. WIDE
PIPELINES
LIMIT FOR LORRY TRAFFIC DURING LOADING AND DISCHARGE
ROAD 3 M. WIDE.
TANKER OF 22,500 TONS.
TANKER OF 22,500 TONS.
POINTS AT WHICH THE FLEXIBLE HOSES ARE ATTACHED.
LIMIT FOR LORRY TRAFFIC DURING DISCHARGE OF OIL CARGO.
LIMIT FOR LORRY TRAFFIC DURING LOADING OPERATIONS
ROAD 4 M. WIDE
TYPE C. LOADING AND DISCHARGE JETTY PERPENDICULAR TO SHORE
METRES

Fig. 5. Three types of tanker berths.

Oil Handling at Ports—continued

Pipelines for refined products; one for aviation spirit, one for automobile spirit, and one for gas-oils. 1 pipe of 12 inches diameter.

SERVICE PIPELINES.

Pipelines for removing ballast and for de-gassing. 1 pipe of 12 inches diameter.

Pipeline for fresh water. 1 pipe of 6 inches diameter.

Pipeline for high-pressure sea-water. 1 pipe of 6 inches diameter.

Pipeline for steam. 1 pipe of 6 inches diameter.

Pipeline for compressed air. 1 pipe of 4 inches diameter.

The width necessary to accommodate all these pipes, in addition to electric and telephone cables is about 7.50 metres; the reinforced concrete deck supporting the pipes is 1 metre below road level in order to avoid interference with free circulation of traffic. Not only should pipes be arranged so that they are readily accessible, but care should be taken that there is no closed space above them in which gas might collect and thus give rise to an explosion.

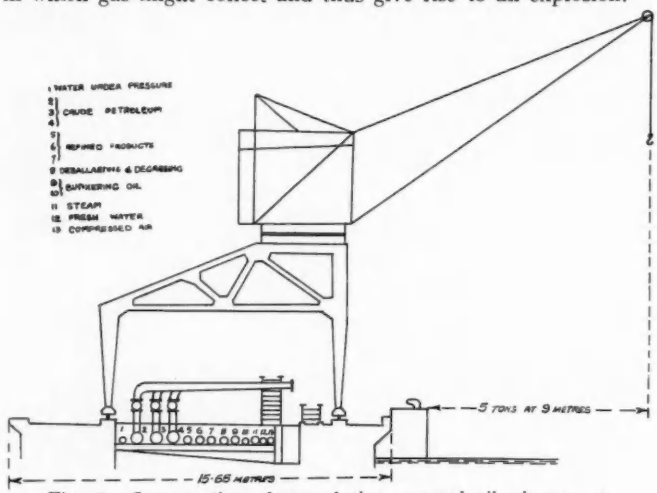


Fig. 6. Cross section of one of the proposed oil wharves at Le Havre.

The flange of each valve connecting the flexible hose with the shore pipelines should be at least 4 metres from the ship in order to avoid any possibility of bending the flexible connections through having a small radius in certain positions of the flexible pipe. Valves and flanges can be arranged vertically, in which case clearance between valve and ship can be reduced to about 2 metres. Flanges should be easily accessible, the men charged with coupling and uncoupling the hoses having a clear space in which to work provided with a non-skid surface; valves can be reached by light gantries.

Flexible hose is available in units of about 20 feet; connections should be able to withstand a pressure of at least 100 lbs. per sq. in.; and it is generally found suitable to use hoses of between 8 and 10 inches diameter, with a working pressure of 85 lbs. per sq. in. To attain a pumping output of 2,500 tons an hour it will be necessary to have three flexible connections. It is thought that in the near future it may be possible for two flexible connections of 12 inches diameter to provide for a pumping output of about 2,400 tons per hour, in which case a single ten-ton crane should be adequate for handling such connections.

FIRE PROTECTION

Protection against fire is another very important factor to be considered in the layout of an oil port. The distance between the nearest storage depot and the ship, should be sufficient to prevent fire passing from one to the other, even if the latter is to windward of the former. Distance between a ship and the nearest storage tanks depends upon the diameter of the latter; since port works are built to last for many years, the layout of the storage depot may be modified during the life of the works, and it is therefore wise to fix the distance between the ship and storage tanks on the assumption that such tanks will be of the largest size available. In France, for example, it is assumed that the maximum capacity for a large oil tank is 20,000 cubic metres, which corresponds to a cylinder about 40 metres in diameter. In the absence of explosion, which should never occur under normal conditions, the distance of 100 metres between tank and ship is enough in every case.

If the layout of the surroundings is too cramped to permit of this rule being applied, a screen wall may be built to prevent the spread of fire, but this is not generally justified, and a ring main with hydrants should meet normal fire fighting requirements. This high-pressure water main may be equipped at intervals throughout its length with spray nozzles from which a continuous curtain of finely sprayed water can be projected. In France there are storage depots located at a distance of 75 metres, or even less, from the wharf side, but it has been observed that distance is not the sole criterion, and that a ship can be swept away in a short period by flames and sparks carried by the wind. According to those who witnessed the fires of June, 1940, which were of course quite abnormal, and can be taken as the extreme case of danger, the hot particles from the fire did not travel as far as 75 metres, and it is therefore reasonable to take this as the absolute minimum distance. Clearance between ship and storage tanks should be at least 100 metres in order to be on the safe side, in every case where the layout of the surroundings permit.

Even if large quantities of petroleum are set alight in a depot, it is usually possible to confine a fire to a single tank, and tank compounds are built so that escaping oil is confined to the compound by closing the usual drainage outlets. In those cases where the soil is impermeable, or where the ground slopes towards an oil basin, it is wise to provide a wide channel between storage depot and basin through which the petroleum can be led to those sheets of water not frequented by shipping.

In order to guard against the building up of static charges in installations, and the possibility of a spark causing a fire, there should be complete electrical bonding of all metallic parts; all waggons, lorries and ships should be bonded to fixed installations, the latter themselves being earthed. Resistance of each earth point should not exceed 20 Ohms and since these points are always subject to corrosion by electrolytic or chemical reaction, the resistance of each should be checked from time to time. If fixed pipe joints are non-conductors, as in the case of joints made with synthetic rubber, it is necessary to re-establish electrical conductivity. In oil storage zones all electrical machinery should be of efficient flameproof construction

All naked lights should be forbidden in danger zones, and ample access must be provided so that in case of fire there should be no hindrance to free passage of vehicles and appliances. Every oil depot should be completely enclosed, and every entrance permanently guarded; there should be a deposit of sand at every joint between fixed pipes and flexible hose, and great care should be taken to see that all combustible material is removed from danger zones. There should be a complete warning system equipped with sirens and klaxons, controlled from different vital points in the port, where an automatic telephone should be installed for communicating with the central safety headquarters and the pump house; it will be a great advantage to provide batteries at each point so that the telephone can be operated independently in case the main telephone circuit breaks down.

Another very important point is the provision, if possible, for shutting down the pumps instantly, in case of emergency, by push-button control but in many oil storage depots the pumps are steam driven, in which cases other arrangements of a similar character should be made. In some climates care should be taken to remove grass in the danger zones, because dry grass may be extremely dangerous from the fire point of view. Since fires often originate from personal carelessness, only the most reliable men should be employed in danger zones, and they should be well trained in the most modern methods of fire prevention. It goes without saying that the crews of tankers should be carefully supervised, especially when they are returning on board their vessels at night.

Oil Handling at Ports—continued

High-pressure water mains, operating at a pressure of from 150 to 160 lbs. per sq. in., are generally used for fire fighting, and they draw their water from the sea at points well clear of oil basins, so that they will not be endangered by oil fires on the surface of the water. In tidal ports it may be useful to instal pumping units on a floating pontoon, and where water is obtained from a reservoir, the latter should have enough capacity to provide for full operation of water sprays over a period of five hours. Sea water under pressure can be used for the production of foam, an extremely useful fire fighting substance.

At petroleum storage depots there should be a fire fighting installation of sufficient size to deal with any fire aboard a tanker or at a loading point. At the petroleum port of Le Havre, for example, there is a mobile foam-making unit mounted on a lorry which can operate at full pressure for an hour and a half, which is considered to be enough time for other fire fighting appliances to come on the scene either from neighbouring depots or from a nearby town. Such a lorry requires about 180 tons of water an hour to enable it to operate at full pressure.

Fire fighting launches can also be extremely efficient, especially where a loading point is to windward of a vessel on fire and where heat prevents ready access to the scene of the fire. The pumping capacity of such a launch is often greater than that of either fixed or mobile shore installations. The fire launch *Alerte* of the port of Marseilles, for example, has three pumps each with an output capacity of 600 tons of water per hour under a pressure of about 170 lbs. per sq. in. Owing to the high capital and maintenance costs of such vessels, large commercial ports do not generally have more than one of them in service, and where they are employed their places of duty should be carefully studied and rigorously defined.

At each loading point there should be adequate emergency safety measures provided; at each joint between flexible hoses and fixed piping there should be two hand extinguishers of ample capacity, using carbon dioxide or chemical solution. At each tanker mooring place there should be a foam extinguisher mounted on wheels, and in each electric crane two extinguishers filled with non-conducting fluid.

For safety reasons, a very strict limit should be imposed on the number of dwellings erected in an oil port, and careful attention should be devoted to storage methods.

TANKER MOORINGS

Careful attention should be devoted to tanker moorings, and the author has been fortunate in obtaining details of the type of mooring favoured by a leading oil company, for tankers from 4,000 to 18,000 tons deadweight carrying capacity and which are shown in Fig. 7; the vessel is assumed to be moored with two wires to each buoy and two wires to each breast chain. Each wire rope is 5½ inches in circumference, and of the special extra flexible blue strand type of 6/37 construction; that is, having six strands each of 37 wires with a minimum breaking strain of 112 tons.

The sketch (Fig. 7) shows the proposed moorings at the Trompeloup Wharf, Pauillac, and they are of extra heavy type; the 50 ton dead men are buried concrete blocks. The spectacle piece F has to withstand a test load of 140 tons, and the cast steel mooring sinkers A, B, C and D weigh 15, 8, 5, and 2 tons respectively. Mooring buoys E are of cylindrical conical type, divided into four

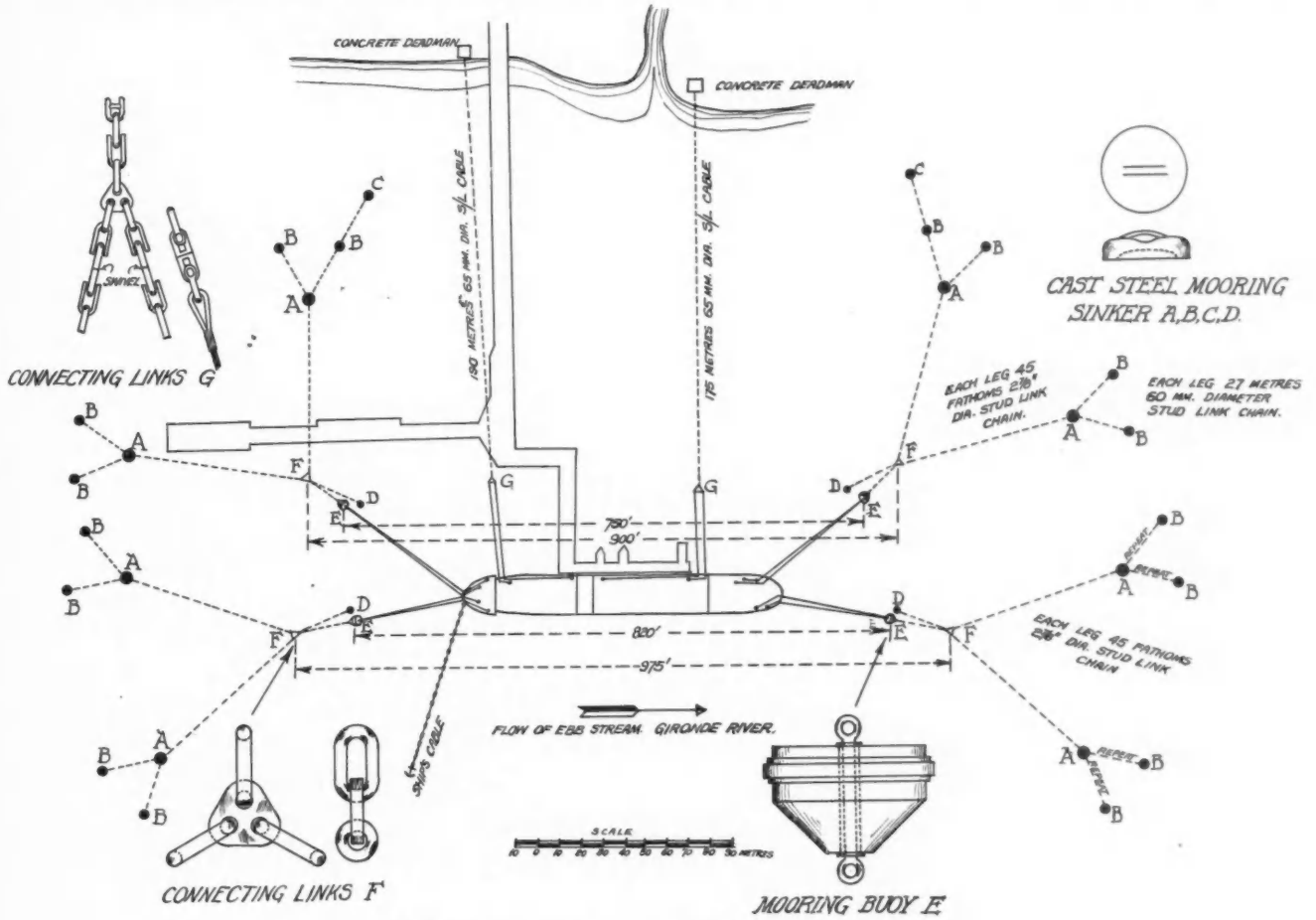

CONCRETE DEADMAN
CONCRETE DEADMAN
180 METRES 65 MM. DIA. S/L CABLE
175 METRES 65 MM. DIA. S/L CABLE
SWIVEL
CONNECTING LINKS G
CAST STEEL MOORING SINKER A,B,C,D.
EACH LEG 45 FATHOMS 2⅞" DIA. STUD LINK CHAIN.
EACH LEG 27 METRES 60 MM. DIAMETER STUD LINK CHAIN.
750'
900'
820'
975'
EACH LEG 45 FATHOMS 2¾" DIA. STUD LINK CHAIN
FLOW OF EBB STREAM. GIRONDE RIVER.
SHORE CABLE
SCALE
10 0 10 20 30 40 50 60 70 80 90 100 METRES
CONNECTING LINKS F
MOORING BUOY E

Fig. 7. Tanker moorings at Trompeloup Wharf, Pauillac.

Oil Handling at Ports—continued

compartments by water-tight bulkheads; they are fitted with a centre bar and elm fenders and are capable of supporting a load of not less than 3½ tons with a freeboard of 20 inches.

Another interesting example of tanker moorings is shown in Fig. 8, which depicts one of the four oil loading berths at Lutong for the loading of tankers, having an average deadweight capacity of 10,000 tons, from shore pipelines. The anchor mark buoy is 1,200 feet from the end of the pipeline, and the bow moorings consist of the vessel's own anchors with about seven shackles in the water; moorings aft comprise four 700 foot lengths of 1¼

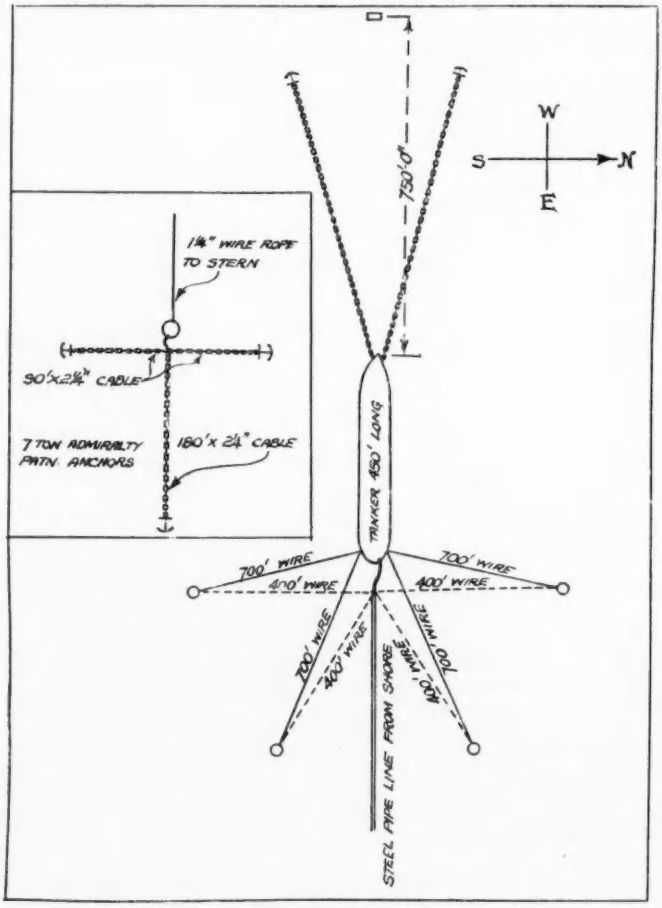


Fig. 8. Tanker moorings at Lutong.

inch diameter wire rope attached to four mooring buoys. The flexible hose connecting the end of the pipeline with the ship is 120 feet long and 8 inches in diameter, a drum buoy marking the end of the steel pipe; the inset sketch shows the groundwork of the mooring buoys aft, connection between the intersection of the three cables and the buoy being by means of 90 feet of 2¼ inch diameter chain cable. It should be emphasised here that the lengths of all mooring wires and cables are fixed by experience on site.

A few general remarks about buoys and their moorings may be valuable. Buoys may be 9 feet 6 inches, 8 feet or 6 feet long, of cylindrical form with diameters of 4 feet 6 inches, 4 feet and 4 feet respectively corresponding to the above lengths. The chains connecting such buoys to the mooring anchors should be of stud link type, 2⅞ inches diameter for the portion in the water and 2½ inches diameter for the portions lying in the mud; the former are found to last from one to four years, and the latter from 18 to 20 years. All chain should be renewed when it shows wear to the extent of one-sixth reduction in the diameter of a link. In Sarawak the wear is so great that moorings have to be renewed about every twelve months.

Experience has proved that the Danforth type of anchor gives best results for moorings. Buoys are located at those points which are suitable to keep the vessel clear of dolphins or other possible obstructions against which the hull could be damaged in the event of a swell.

ACKNOWLEDGMENTS

The author is grateful to a leading oil company for the help and guidance that they have so generously given him in the preparation of this article. He is also grateful to Monsieur H. Deschenes, Chief Engineer of the Autonomous Port of Le Havre who has kindly supplied him with information and photographs.

Iron Ore Discharging at Port of Newcastle

Modern Plant and Handling Equipment for Tyne Dock

Consett Iron Company Limited and the Tyne Improvement Commission recently announced the successful conclusion of negotiations as a result of which the Consett Iron Company's increasing requirements of foreign ores will continue to be imported at Tyne Dock for a considerable number of years.

In order to handle the increased quantity which, it is anticipated, will ultimately be in the region of 1,000,000 tons per annum in the most economical manner, as well as to effect the quickest possible turn round of ore-carrying vessels, the Commission will, under the arrangement, build an extension to the Sunderland Quay on the river at Tyne Dock suitable for berthing vessels of up to 20,000 tons capacity, and install on the new quay the most modern and up-to-date ore discharging and handling equipment in the country. The cost of the project is estimated at nearly £1,000,000 to which Treasury sanction will be required.

The ore will be discharged by a battery of five 10-ton grabbing kangaroo cranes and will be weighed automatically as it leaves the crane hoppers on to conveyor belts, which load the main storage bunkers of a total capacity of 7,500 tons to be constructed in such manner as to allow of further extension in the future if required. Travelling weigh cars will transfer the ore from the main storage bunkers to two sets of nine 56-ton capacity hoppers so spaced as to coincide with the wagons of the trains into which the ore can be loaded simultaneously by the operation of electrically-driven doors on the hoppers.

British Railways are co-operating in the general scheme and are providing composite trains of specially designed wagons to be operated on a fast shuttle service between Tyne Dock and Consett.

The Consett Company are providing special arrangements for dealing most expeditiously with the trains on arrival at Consett. A special ore gantry is being constructed to receive the loaded trains which will be discharged in a matter of minutes and sent on the return journey. The ore will be fed to the furnaces, to the crushing and grading plant or to the stock piles and sinter plant by the latest type of ore bridge and conveyor plant.

This arrangement marks a further most important step in the large scale development scheme at present being carried out at Consett. A new blast furnace plant consisting of three of the most modern blast furnaces in the country has already been completed together with additional coke oven capacity, new gas-cleaning plant, new central Power Station and other general developments all of which justify the Consett Company in going forward with the erection of a modern high capacity heavy Slabbing and Blooming Mill together with a new continuous Slab and Billet Mill. Orders for these Mills have been placed, the cost is approximately £5 million and it is anticipated that this new machinery will be in operation in 1952 by which time it is also hoped that the new ore discharging, handling and transporting facilities will be available.

Australian Port Developments

Work in Progress on Three Important Schemes

SINCE the conclusion of the recent war, far-reaching plans have been put in hand for the improvement and development of certain Australian ports, and work on a number of the projects is well in hand. The following details of three of the schemes, showing the progress made to date, have been supplied by the Australian Information Bureau, to whom we are also indebted for the accompanying photographs.

New Docks for the Port of Melbourne

By A. D. MACKENZIE, M.I.C.E., M.I.E. (Aust.), C. E.
Chairman of the Melbourne Harbour Trust

Large-scale development of berthage facilities at the port of Melbourne, will meet the rapidly growing needs of world seaborne trade flowing through this modern gateway to the State of Victoria.

Work has been proceeding for sometime on the long range construction project designed to keep the expansion of Melbourne's port facilities abreast of the economic developments taking place in Australia.

With little help from nature, the builders of Melbourne's port have kept pace with the growth of the State and established port facilities known to the seafarers of every maritime nation.

The accession of Queen Victoria to the throne of England in 1837 inspired the loyal citizens of the then infant settlement to name their wharf "Queen's Wharf." About the same time Governor Bourke changed the title of the site from "Bearbrass" to Melbourne. In that year 140 ships visited the port of Melbourne and goods worth £115,000 were imported by the pioneer settlers. By 1841 imports had risen to £364,000 and exports to £200,000.

These were small beginnings, but they set the pattern for the development of what is now the seventh city of the British Commonwealth of Nations—and for its port. Last year, the value of Victoria's imports came to more than £150,000,000 and exports £116,000,000—90 per cent. of the trade passing through the port of Melbourne. Although Victoria comprises only 1/34th of the Australian mainland, a quarter of the Commonwealth's population lives in the State, poducing new wealth valued at £200,000,000 annually.

The mud river-wharf of 1837 was a modest affair, but it can be worthily incorporated into the general design of evolutionary progress, for time has proved that the longshore wharf is ideally suited for handling Melbourne's general trade, allowing proper transit sheds at each berth, adequate rail and road approaches, and erection of conveniently placed warehouses for cargo storage. The modern wide concrete — surfaced wharf apron, served by banks of level luffing electric cranes, is a logical elaboration of the primitive mud-wharf around which early Melbourne grew.

Today the port of Melbourne affords longshore berthage for 75 ships at Victoria Dock, North and South Wharf, and at Newport and Yarraville oil wharves. The system is to be greatly extended and the programme now in hand provides for a further 18 berths in Appleton Dock, and five berths initially at new River Entrance Docks. Ultimately there may be 20 longshore berths for large ships at the river entrance, and 50 berths between the

River berths of the Port of Melbourne showing, dotted, the area which will be occupied by the new Appleton Dock.

Australian Port Developments—continued

Maribyrnong River and Victoria Dock.

The first stage of construction at Appleton Dock, west of Victoria Dock, is now well advanced. Immediate proposals in this vicinity will involve an expenditure of about £1,500,000. Three new cargo berths are to be constructed on the north-western side of the dock, together with two berths specially equipped for coal handling. The general cargo berths will have reinforced concrete wharf aprons 54-ft. wide, with three rail tracks, and tracks for 6-ton and 3-ton portal electric wharf cranes.

The transit sheds will be single storey type 150-ft. wide and of fire proof construction. Shipping and customs officers will be grouped in one end of the building, leaving the maximum of clear floor space for cargo stacking. Mobile cranes and fork lifts will be able to work unhampered on the concrete floors, and their operation will be facilitated by use of shed doors 20-ft. high and 20-ft. wide.

The rear of the sheds will be elevated 3-ft. 6-in. above the roadway to provide a loading platform for vehicles. All sheds will be provided with dining rooms, toilet facilities and other amenities for port workers.

On the inner side of the dock two berths will be equipped with 7½-ton grabbing cranes for the discharge of colliers. These cranes will discharge either into hoppers over railway trucks on the wharf, or at the rear of the wharf where the coal will be loaded into vehicles, or stacked with drag scraper equipment.

The powerful cutter-suction dredge " G.F.H." is now working at the Appleton Dock site, cutting away clay and sand. The material is pumped through 45-in. diameter pipes and carried to the West Melbourne swamp area where it is being used for land reclamation. A boggy marsh is steadily being converted into a firm foundation for wharves, sheds, and rail and road approaches.

When Appleton Dock is completed, it will have a water area of 60 acres, a water width of 600-ft., and will provide berthage for 18 ships.

While the River Entrance Docks are still mainly in the planning stage, tenders have been invited for the dredging of about 4,000,000 cubic yards of silt in the area and work has been commenced on placing material for reclamation banks. Behind these banks. 2,000,000 yards of yellow clay will be pumped by the cutter suction dredge " G.F.H." (after the silt has been cleared), forming sites for roads and railways, transit sheds and warehouses.

This site is particularly suitable for docks as it embraces the most sheltered portion of Hobson's Bay, and good clay is encountered there at moderate depths. It is conveniently situated for connection to existing dredged channels, and can readily be afforded rail and road approaches. Within the limits of good foundation conditions, 20 berths for large ships can be provided in the River Entrance Docks.

The first section of five berths will cost about £3,000,000 and authority for construction has been given.

The port of Melbourne's new wet docks—Appleton Dock and the River Entrance Dock, will be adequately equipped with the latest mechanical equipment. A multiplicity of level luffing wharf cranes and modern coal grabs, are to be installed. For heavy lifts, 600-ft. of frontage is being set aside near Appleton Dock for the erection of a luffing and slewing jib crane of either 120-ton or 150-ton capacity.

Generous provision of railway tracks will be another feature of the new wharves. Of the 104 berths in the port, over one-fourth are already linked with the Victorian Railways system, which has, at present, a total of 4,748 route miles of track and will be continued and extended in the new projects. The combination of wharf cranes and railway facilities has paid untold dividends in the rapid loading and unloading of ships, and the effectiveness of the integrated service has been equivalent to many more berths in the port, so that past experience will be the best guide for future installations.

It is a fundamental principle of port administration that a great port is never completed, for the world of trade and commerce does not stand still, and a port cannot afford to do so. New methods and technologies must be applied to meet ever-changing conditions. The story of the port of Melbourne is that of a man-made port, unassisted by any of nature's gifts. It is a continuing story of steady, unfaltering progress, and the plans for the new wet docks add another chapter.

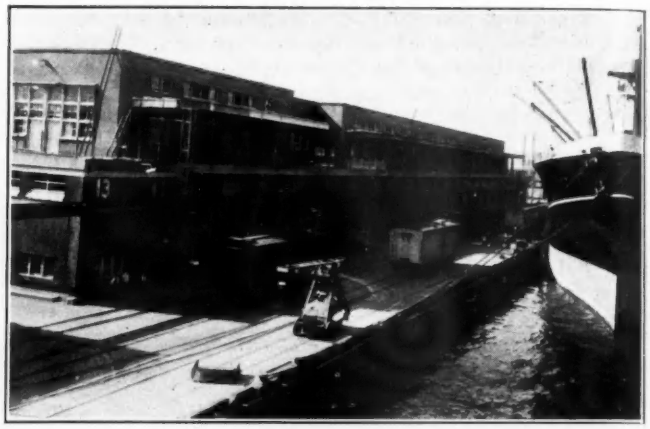
Port of Sydney Wharf Rebuilding Plan

By JUSTIN ARTHUR.

Engineers of the Maritime Services Board, New South Wales, have begun the remodelling of Sydney Harbour wharf accommodation. Plans include rebuilding wharves at Pyrmont, in the south-east corner of the Harbour, at a cost of £A2,000,000 and at the adjoining Darling Harbour, at a cost of £A3,000,000.

The Pyrmont scheme, which has been started first, includes moving coal wharves from Pyrmont to White Bay (to the west) and installing facilities for handling big ships from overseas. It is the first major rebuilding job on Sydney Harbour since the end of the war.

Work done at Number 13 berth, Pyrmont, has reached an advanced stage and it is expected to be ready for use by the end of this year. A two-deck shed has been built with an overall length of nearly 500-ft., the upper deck of which contains special features for the reception of overseas tourists and migrants. There is a 300-ft. customs hall, a caféteria, tourist bureau and rail ticket office and offices for banking representatives.



A Two-storey Shed at No. 13 Berth, Pyrmont. Facilities for tourists and migrants are on the upper deck.

Direct access to the upper deck is by an elevated road which leads from a city thoroughfare, and the upper deck is supported by steel beams, hinged in the centre to allow for expansion. The beams are designed by Maritime Services engineers.

Because of the increasing demand for railways on the waterfront, rail tracks will be installed at all the new and rebuilt wharves at Pyrmont. Overseas cargoes will, where necessary, be loaded direct into trains, which will be able to link up with the main State rail system.

The £A3,000,000 Darling Harbour plan includes the rebuilding of about 28 wharves, which will be placed in echelon pattern instead of at right angles to the foreshore, as at present. Echelon wharves allow ships to berth more easily. All the new and rebuilt wharves will be two-deck, with roadways leading to both decks.

In Sydney, the Maritime Services Board is following the United States system of installing mobile cranes to move freights to sheds and into road and rail vehicles after ships' gear has transferred it from the holds to the wharves. The Harbour has 15 mobile cranes, compared with only five before the war and more have been ordered.

This mobile crane system contrasts with the usual British and European practice of installing wharf cranes and handling all cargo direct from ships' holds with them.

Commercial wharves in use in Sydney (not including ferry wharves) total about 14 miles in length. Wharf sheds cover 3,200,000 square feet—about 73 acres.

Australian Port Developments—continued

The New River Port of Iluka

By ANGUS BRAMMALL.

Work was commenced last June on a three-year programme for building a new river port, costing £A3,000,000, near Iluka, at the mouth of the Clarence River, 300 miles north of Sydney. This scheme will help to develop 8,000 square miles of the richest pastoral and agricultural land in New South Wales and provide an outlet for its products.

The Clarence River, one of the finest waterways in Australia, is 247 miles long, and the width of its lower reaches, from the Pacific Ocean mouth to the City of Grafton 48 miles upstream, is nowhere less than 800-ft. It is more than 40-ft. deep at Grafton and at Maclean, 12 miles from the mouth, there is 60-ft. at the anchorage. Plans for the new port include the removal of a rock reef and a sand bar which have hampered navigation in the past.

Last year, the Clarence River was used by 68 vessels, mostly barges and small coastal steamers, totalling 27,166 tons. Upstream cargo amounted to 12,999 tons, downstream cargo was 24,745 tons. These figures are expected to be trebled when the port improvements have been completed.

Fed by sub-tropical thunderstorms and the winter snows of the New England Range (an arm of the Great Dividing Range which skirts Australia's east coast), the upper waters of the Clarence River rush through ravines and gorges to irrigate the fertile lands below. The population in this area exceeds 50,000.

Settlement of the river began as far back as 1838, when timber cutters found valuable red cedar growing in the area. The population grew quickly and Grafton city was incorporated in 1859. A year later, Sir Henry Parkes, Premier of the State of New South Wales and one of Australia's most famous statesmen, visited the area. He attached great importance to the development of the lower Clarence into an efficient port.

Harbour improvements began in 1862 with the building of the 1,520-ft. southern breakwater and a 24-ft. high retaining wall along the foreshore inside the entrance. A northern breakwater and bank protection 1,000-ft. long was also built. Between 1893 and 1903, retaining walls were built on Goodwood and Freeburn Islands, near the river's mouth.

There are 99 islands in the Clarence River, the biggest of these being Woodford Island, said to be the largest "inland" island in the world. More than 10 miles long and five miles wide, Woodford Island has several townships scattered over its 40 square miles. Graziers and farmers on the island have bridge and ferry communication with the mainland.

The proposed port entrance works provide for building a new northern breakwater 4,200-ft. long starting 600 yards north of the end of the existing breakwater. The southern breakwater will be extended 1,800-ft. leaving a 1,400-ft. river channel between northern and southern breakwaters. The 15 to 20-ft. wide breakwaters will be built to 24-ft. above mean low water mark.

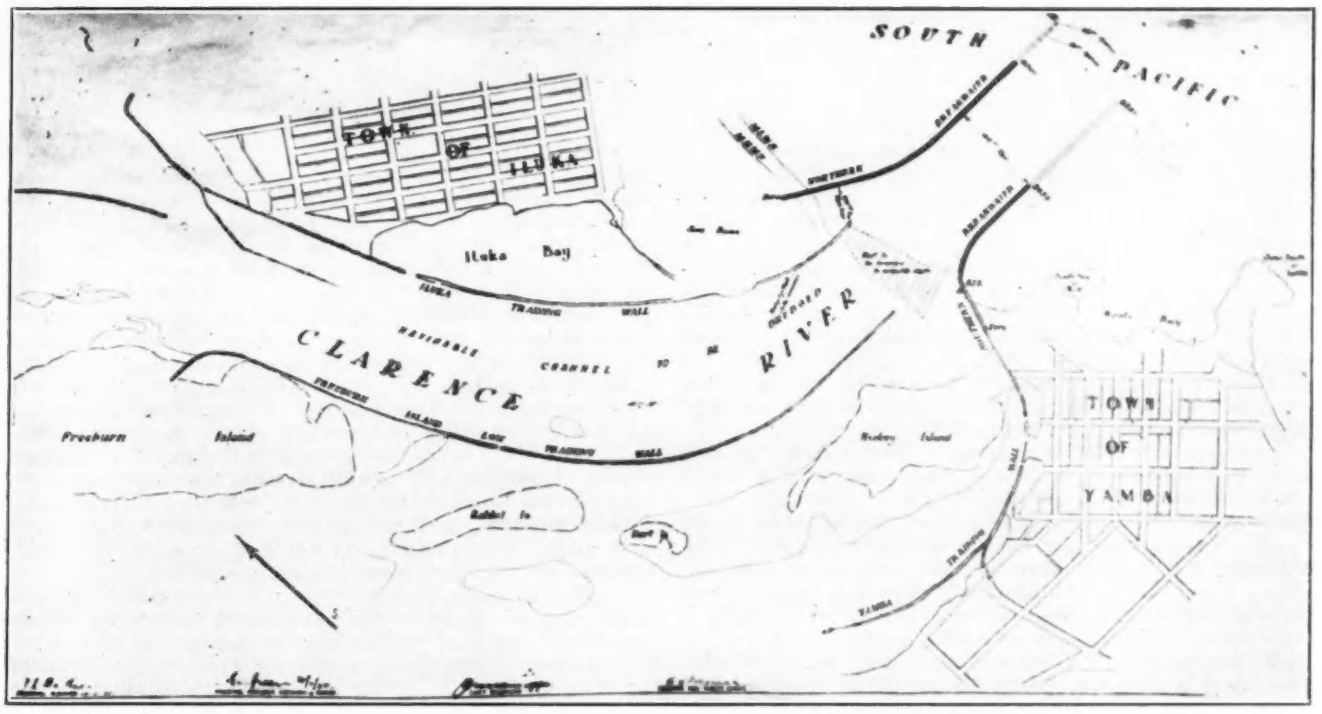
An old, half-submerged wall, known as Moriarty's Wall, which juts V-like almost to mid-stream from the north bank, will be demolished and the rocky entrance reef and sand bar beyond it will be removed to make a low water depth of 20-ft. Inspection of the sea bed has revealed the formation of a pronounced delta at the river's mouth. Silting has also become a serious matter, necessitating almost continuous dredging above the sand bar.

The new works should help to remedy this, for the breakwater extension will funnel the Clarence's outlet, thus increasing the waters' velocity and dispersing sand and silt into the ocean. The need for dredging should therefore be greatly reduced.

Building materials for the port will come from Woodford Island, where 15-ton limestone blocks will be quarried and taken to Iluka and Yamba at the north and south entrances of the Clarence. As the work advances into deeper water, 20 to 40-ton concrete blocks will be fabricated in a blockmaking plant on the island.

There is no plan for large-scale wharf-building in the three-year scheme but as river trade increases, more berthing space will be provided.

Incorporated with the river development plan is a £A10,000,000 project to increase hydro-electric output in the Clarence Valley. The central point of this scheme is the hydro-electric station at the Clarence Gorge, 50 miles upstream from Grafton and 150 miles south of Brisbane. The Gorge is about six miles long, with a width of from 300-ft. to half-a-mile. In less than one mile, the stream falls 60-ft. in a series of cascades. Enough water can be impounded to generate 75,000 kilowatts of electricity.



The Clarence Harbour Works showing the sites of breakwater extensions, dredging and demolition of old revetment wall.

Some Modern Cargo Handling Appliances

Review of Mechanical Equipment used in British Ports

By E. S. TOOTH.

(continued from page 114)

(5) GRAIN HANDLING MACHINES, CONVEYOR SYSTEMS, OVERHEAD CRANES, "STRADDLE" CARRIERS, RAIL-MOUNTED CRANES.

The first four articles of this series dealt with machines employed for handling most descriptions of cargoes into or out of ships and through sheds and warehouses. Apart from the "general" goods which pass through British ports, however, there are "special" goods—i.e., goods requiring special facilities, and handled in sufficiently large quantities to warrant the allocation of special berths and the installation of special equipment. Among these are a number of foodstuffs—grain and meat, for example—and also such commodities as, say, metal pipes and hardwood logs. Although a large percentage of foodstuffs is delivered immediately out of the port system, a certain proportion is required to be stored. A berth alongside a granary for a grain ship or one adjacent to a cold store for a meat ship is, therefore, obviously an economic arrangement. The capacity of a granary may run to several large ship-loads of grain and that of a cold store may be rated in terms of hundreds of thousands of carcases of meat. When it is realised, too, that in London, for example, well over half-a-million tons of meat pass over the dock quays in the course of a normal year, the need for special equipment is obvious.

GRAIN HANDLING MACHINES

Meat is moved from ship side direct into cold store on a conveyor system, stems of bananas and cases of green fruit being discharged from ship by similar means, while at some ports there are pumping and pipe-line installations for dealing with liquid cargoes. For handling grain there are bucket and pneumatic machines, and as far as the machines themselves are concerned, the bucket elevator is probably cheaper to run. According to tests which have been made, however, the cost *per ton* of grain handled is slightly less when the grain is discharged by the pneumatic machine. In the main this is due to the fact that, because the pipe-line nozzles are easier to handle and involve less trimming of the cargo than the boot of a bucket, the pneumatic machine can keep up a higher rate of discharge for a longer period, even when its maximum capacity is only the same as that of its bucket counterpart. In short, the bucket machine needs more men trimming and needs them earlier.

The other advantages of the pneumatic machine are that air-tight pipes are obviously "cleaner" than belt conveyors or bucket elevators and also that pneumatic pipes can run over or under roads, railways, cranes and other obstructions and round corners in a manner not possible with mechanical conveyors.

At many ports one will find fixed, travelling, floating and sometimes mobile grain plants. The shore machine which discharges grain from ship to store and lighter, consists of a number of fixed discharging towers, each of which is a self-contained unit with its own suction pipes and its own battery of automatic scales. The grain is drawn by suction from the hold of ship or barge to a chamber in the tower, from which it is automatically evenly distributed between the scales. After weighing, it is shot to craft or to a conveyor belt system which takes it to the adjacent granary for storing or perhaps to an elevator which conveys it to a tank for immediate delivery to road or rail vehicle.

In these machines, as in their travelling and floating counterparts, the conveying air is moved by a reciprocating piston vacuum pump or exhauster (the method normally preferred), or a turbo exhauster. These may be steam, oil or electrically driven, and as with other mechanical cargo-handling machines, one essential is reliability, for a breakdown means a ship delayed.

In certain ports there are flour mills adjacent to the quay which are equipped for discharging grain cargoes for processing in the mills themselves. Grain does not always arrive as a whole cargo, however, neither is it always for storing within the port system. One need for the floating elevator, therefore, is to discharge grain from ships which are at the same time unloading other cargo. These machines work on the same principle as the fixed machines. The wheat, barley, oats or maize is drawn up into a canister above the weighing room, evenly distributed by automatic means to the scales, weigned and delivered to the barge either in bulk or into sacks, which are tied and stowed manually. Floating elevators are moved from hold to hold, ship to ship and dock to dock as occasion demands, discharging part or whole cargoes of grain into craft, weighing where necessary and giving bulk or bag delivery as required.

A typical floating pneumatic grain discharging plant is the "Thomas Wiles" (Fig. 1) designed and built by Simons Handling,

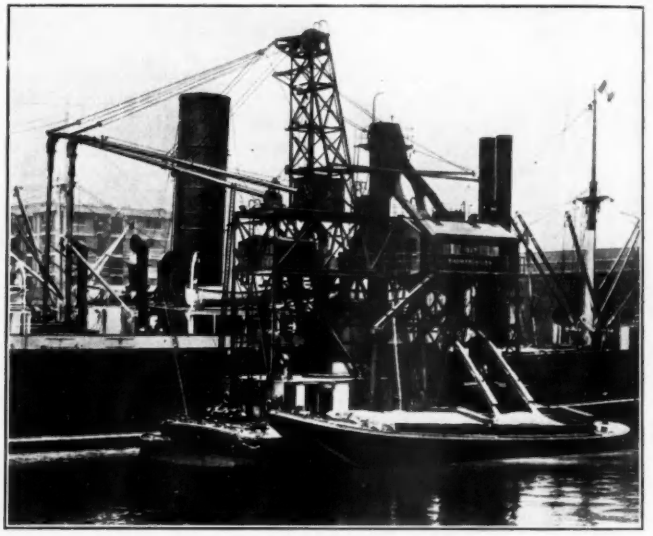


Fig. 1

Engineers, Ltd., to discharge any vessel, large or small, using the Port of London. This machine, which is equipped with two suction nozzles and intake pipe lines, has a maximum capacity of 150 tons per hour, thus ensuring an average output over a large hold of over 100 tons per hour. The two reciprocating vacuum pumps are directly driven by a vertical steam engine. The steel pontoon upon which the unit is built includes crews' quarters, store room and ballast tanks and the elevator can work with the pontoon placed either "end-" or "side-on" to the ship.

To effect discharge from ocean-going ships into port granaries and flour mills, travelling plants are frequently installed. These are in effect travelling towers which operate along the quay on rails, each tower having nozzles and intake pipes to a single receiver. These machines usually have two towers and are so constructed that the fore and aft holds of ships can be discharged simultaneously at speeds of up to 200 tons per hour or more.

Portable elevators are not common in our ports, and those which are used, are usually of the suction type, diesel driven. They have a capacity of up to 30 tons per hour and although they do not weigh, they are useful for such work as delivering from barge to road or rail vehicle or onto the conveyor belt of a granary.

At some ports, machines are employed which work on a different principle from that of bucket and pneumatic elevators. These operate mainly on the quay, a few being portable but the majority fixed plants. By them, grain is caused to flow, without pressure

Some Modern Cargo Handling Appliances—continued

on the particles, through enclosed dust-tight casings in any direction by means of skeleton-type links which themselves travel inside the casings. The machine is self-feeding, electrically driven and can feed or discharge barley, bran, maize, oats, rice and wheat at speeds of 60 to 100 and even more tons per hour, according to the dimensions of the equipment installed. It is indeed, a type of conveyor system.

CONVEYOR SYSTEMS

The movement of cargo by means of conveyor systems is a method employed at many British ports and conveyor belts, aerial ropeways, electric escalators, etc., are installed, usually as special-purpose equipment. At Bristol, an aerial ropeway approximately seven-eighths of a mile long, connects a berth in the Royal Edward Dock with a large smelting works and a fertilizer factory and is used for the conveyance of the imported raw materials (zinc concentrates, phosphate rock, etc.) from ship to the works. This ropeway can also be used in reverse for the export of bulk traffic. At the same port an electric escalator, in overhead gallery, is used to convey loaded trollies of meat and other refrigerated produce from the upper floors of the transit shed to the respective floors of the cold stores, thus reducing to a minimum exposure of the

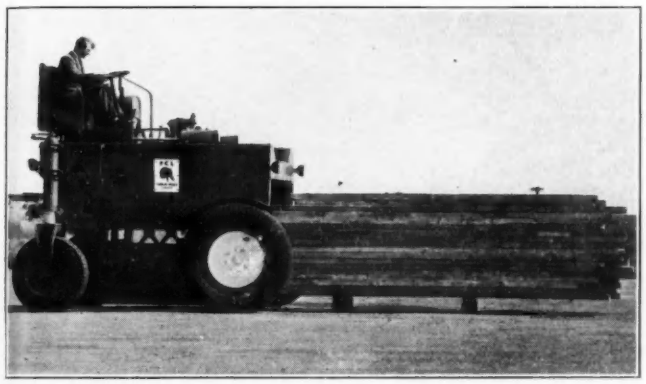


Fig. 2

refrigerated cargo. The empty trollies are returned to the transit shed by means of a second escalator. One of the meat berths at Liverpool is similarly equipped and meat landed on to the conveyor is moved direct into Cold Store.

The unloading from ship of bananas affords a typical example of the use of belt conveyors. A banana discharging berth in London is equipped as follows: Elevators, with weather hoods, and each consisting of an endless band of canvas pockets, are lifted aboard the vessel, one leg of each elevator being lowered into the ship's hold, the other leg serving a conveyor belt on the quay. The men in the hold feed the stems of bananas, one into each pocket. When the elevator pockets reach the quay conveyor, they automatically release their load, and, so as to prevent damage to the fruit, a man carefully turns each stem on to the conveyor belt. At this point there are " Sorbo " pads also to prevent damage, and in addition there is an automatic ray tally machine which counts each stem as it passes along the conveyor. By a system of distributing belts, the stems are conveyed either to rail or road vehicle.

The machine is electrically driven and the speed of any part of it may be regulated at will. With the aid of this equipment a ship with a full cargo of 1,600 to 1,700 tons (say, 160,000 stems of bananas) is discharged and all the fruit delivered direct in approximately four 8-hour working days—and with the minimum handling. Besides being tallied automatically at the point of landing, the stems of bananas are tallied individually by clerks at the time of loading and the vehicles are passed over a weigh-bridge before they leave the port system in order to establish the weight of the fruit each contains.

Another use for conveyors is where cargo is " worked " before delivery from the port system takes place. For instance, rum is vatted and bottled, and wine is " fined " and bottled. In the mechanised premises where these operations are performed, conveyors are often employed for moving bottles and cases from one stage of the operation to the next. It is when large packages and pieces have to be handled, such as half-ton hogsheads of tobacco and heavy logs of hardwood which are beyond the capacity of fork lift trucks, that some other method of transporting them is necessary and travelling hoists and overhead cranes are usually preferred.

OVERHEAD CRANES

The electrically driven overhead travelling crane is built into a traveller supported on rails high up in the structure of the premises. The traverse carriage runs the length of the traveller, i.e., athwart the premises and the whole machine runs the length of the gantry rails, i.e., from end to end of the premises. The simpler type of overhead travelling crane has no jib. It is in fact a travelling mechanical winch of a capacity of up to 6, 7 or 10 tons and can plumb some 90 to 95% of the floor area of the premises in which it is installed. The more complicated type of machine is the overhead underhung travelling crane, in the design of which is incorporated a slewing and derricking jib. This crane will not only plumb the whole of the floor area of the building in which it is installed but the jib will reach bays in adjacent floors and also reach outside the ends of the building, plumbing roadside, quayside and, in some cases, barges. The motions of the crane and the movement of the traveller are controlled from the driver's cabin, which forms part of the " body " of the crane. These cranes are manufactured in various capacities according to needs, a " utility " machine having a safe working load of from one to three tons. Like the electric hoist block—whether power travel, push travel or hand geared travel—running on a monorail, one great advantage of the overhead crane is that it occupies no floor space.

This advantage is indeed so great that there is a body of opinion which advocates the installing, wherever possible inside port premises, of overhead travelling jib cranes for use instead of " floor " machines such as mobile cranes and fork lift trucks. There is no doubt whatever of the efficiency of overhead cranes—they are fast and they enable the maximum use to be made of the floor area and shed height. Three factors operating against their installation, however, are (1) they cost much more than the " floor " machines, (2) they are not mobile, and (3) whereas mobile equipment can be obtained in weeks, overhead cranes usually take a year or more.

" STRADDLE " CARRIERS

Another method of conveying baulks of timber, iron pipes and other similar goods is by petrol or diesel driven " straddle " carrier.

These machines are usually employed in the open and are manufactured with capacities varying from 3 to 20 tons and with speeds of up to 50 miles per hour. In appearance they resemble a large four-wheeled tractor with cargo space underneath the chassis. The machine straddles the load, picks it up, conveys it and sets it down at the point required. The hoist machinery of the Ross Carrier consists of four heavy duty screws running in large bronze nuts and is claimed to be the simplest and most powerful of all carrier load hoists. In Bristol a Ross Straddle Carrier fitted with a 72 h.p. engine and capable of carrying 6½ tons is used for conveying timber (sawn or log) from the discharging berth to the piling ground. The size of the maximum load it can handle is 52-in. wide and 49-in. high. This machine helps to keep the quay clear alongside the discharging vessel and at the same time avoids the use of internal user wagons.

In Manchester, Ross Carriers are used in connection with the discharge of cargoes of softwood. The sets are landed in single rope slings on to the quay, where the straddle carrier picks up one, two or three sets at a time and conveys them distances of 150 to 500 yards to the stacking ground.

The " Ross " is an American machine but a straddle-type carrier is now in production in this country. The British machine (see Fig. 2) which is being made by Pest Control Ltd. of Cambridge is designed to straddle a load of timber or other material 42-in. wide, 48-in. high and up to 29-ft. in length. This is equivalent to a softwood timber load of 5 tons, which can be raised 9-in. in 5 seconds and carried at speeds of up to 20 miles per hour.

Some Modern Cargo Handling Appliances—continued

A prototype of the machine was exhibited at the Mechanical Handling Exhibition in London in June 1950. Powered by a Fordson V.8 engine, it has a wheel base of 7-ft. 9-in., an overall width of 7-ft. 6-in., an overall height of approximately 11-ft. and a turning circle of 18-ft. diameter to inside wheels. Steering is by ordinary steering wheel and braking by internal expanding brakes fitted to the inside of the front driving wheels.

RAIL-MOUNTED LOCOMOTIVE CRANES

On premises having rail facilities, the opportunity presents itself to use rail-mounted cranes and for several decades the steam crane has been an excellent servant to Dock and Harbour Authorities. Its motive power is now in course of being replaced by the diesel engine, but it must be stated that the opinion of regular users of steam cranes is not unanimously in favour of this change. Steam cranes are very reliable, but one of their disadvantages, is that the fires have either to be " banked " during non-working hours, or extinguished at close of work and lit again before work commences, processes taking time and costing money.

The modern type of locomotive shunting crane is now usually powered by a diesel electric or straight diesel engine. Built on the same operating principle as the mobile crane, its safe working load varies with the angle of the jib. Besides being used for handling " general " cargo—quite frequently, of course, to and from rail wagon—many such cranes are employed specially for handling heavy export packages and also goods such as logs of timber.

A " standard " crane of this type has a lifting capacity of 5 tons at a radius of approximately 16-ft., and 1 ton at 30-ft. to 35-ft. radius. Hoisting speeds vary with the load being lifted; at 5 tons it is up to 120-ft. per minute. Unladen, the cranes weigh between 25 and 30 tons, and laden, they can travel at some 4 miles per hour. As with the mobile crane, many locomotive cranes are fitted with a safe load indicator with an audible and visible warning device.

A locomotive crane typical of those employed in British ports is the 5-ton crane made by Thomas Smith & Sons (Rodley), Ltd., of Leeds. With a standard 40-ft. jib it will lift 5 tons at 16-ft. radius, 4 tons at 18-ft., 3 tons at 22-ft., 2 tons at 28-ft. and 30 cwts. at 33-ft. radius. The maximum hoisting speed is 120-ft. per minute and at minimum radius the height of the lift 36-ft.

The crane is operated by a four-cylinder diesel engine, power being transmitted through a hydraulic coupling with reversing clutches for slewing and reversing; dog clutches for travelling and luffing motions. A complete house is provided, affording full protection to the superstructure, machinery, engine and driver. All driving control levers are grouped at the front of the house, giving the driver entire control for all operations. The carriage is an electrically welded all steel structure and is fitted with draw gear and buffers when required. These cranes are made with various capacities. The machine illustrated (Fig. 3) is a 6-ton model.

In considering mechanical aids to cargo handling, it is easy to ignore the point already stressed, viz.: the difficulties arising from the miscellaneous nature of cargo and the varving conditions under which it has to be handled. A factory can be planned and built for the production of a particular commodity in packages of uniform dimensions, and the same article can be turned out year after year. It is not possible in the same way to choose a site for and to plan a port. Ports have to be fitted into a natural environment and geographical factors often control its construction and therefore determine what size and type of ship it can accommodate. Moreover a port does not produce goods, it sells facilities. There is no such thing as a standard article in port work. There is no standard ship, no standard shed, package or conveyance. The Port Authority or the Contractor must be ready to handle any type and weight and size of package either inwards or outwards and must have a sufficient variety and range of machines to handle it quickly. For speed of work, machines must be manœuvrable and easy to operate and buildings must have easy access for them. If these points were not taken into consideration when planning new premises and ordering new machines, port work would be subject to long delays. A modern berth, besides being equipped with up-to-date electric cranes, may be " backed " by a quay shed (of two or three storeys if necessary) complete with loading platforms, balconies, electric wall cranes, conveyor equipment and railway tracks, besides the mobile cranes, platform trucks, fork lift trucks and tractors which are necessary " additional " equipment if the fullest and speediest use of the shed and its adjacent ground is to be made. Timing is also a factor in efficiency, especially where special cargoes are concerned. The co-ordination of the attendance of road and rail vehicles for receiving bananas and meat, for instance, direct ex ship, is as important in terms of " turn round " as is the increase in speed gained by the employment of mechanical aids. This postulates, the need for an efficient railway system.

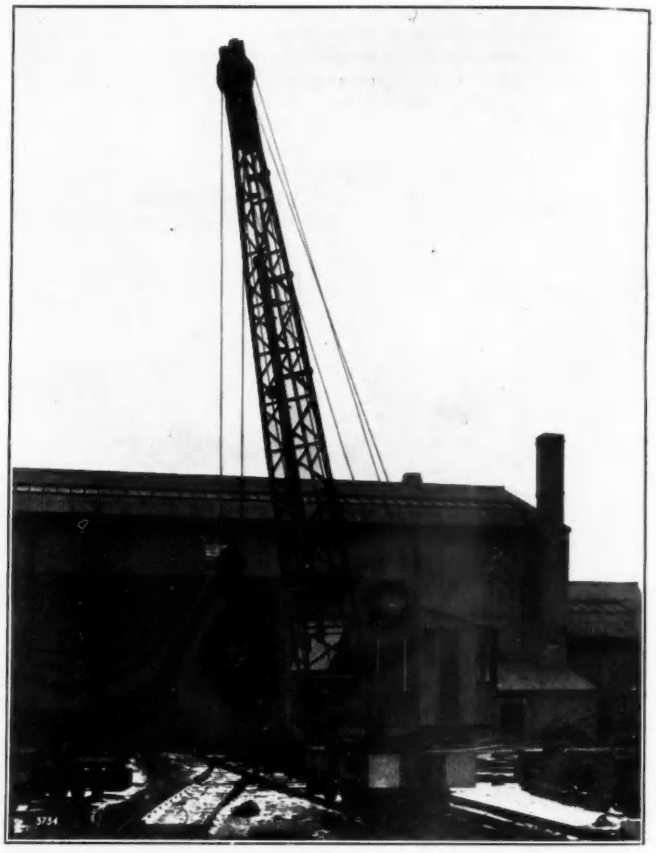


Fig. 3

To sum up, ports exist to transfer goods from sea to land or vice versa and the aim of Port Authorities is to do this efficiently. This task, in its turn, implies the long term planning of premises and an enterprising attitude to the provision of a wide range of mechanical equipment able to work with speed and safety. There is no doubt that manufacturers of British machines are well aware that the requirements of a modern port are fundamentally different from those of a factory and that they are always doing their utmost to meet them.

But their task is no easy one. Not only is there no such thing as a standard machine, there is no such thing as an " all-purposes " machine for port work. The manufacture of an " all purpose " mobile crane has been considered by more than one manufacturer but the requirements of one port alone are so varied that there are few features which can be incorporated in all the variety of cranes required.

The shipowner's attitude to the introduction of new mechanical handling appliances is one of active support, for is not the primary object of these new machines to speed the " turn-round " of ships? The vital factor at the present time, however, is the dock workers attitude. Most cargo-handling machines make port work less

(concluded on page 167)

Glued Laminated Timber Structures*

By R. T. WALTERS, A.R.I.B.A., A.M.I.Struct.E.

INTRODUCTION

LAMINATION is the process of building up comparatively thin pieces of timber into larger members which may be either straight or curved. The pieces are bonded together with glue, or sometimes with mechanical fastenings. The grain of the laminates is parallel, in contrast to plywood in which the grain alternates with each lamination.

Considering a simple component such as a beam, it is evident that the laminates may be arranged in one or two ways. One method is to place them vertically (Fig. 1). In this case it can be shown by statistical analysis that the effect of defects on the strength of the beam decreases as the number of laminates increases. Higher working stresses in bending may therefore be assumed for a given grade of timber than would be permissible if the member were solid. For three laminates the strength increase factor is 1.5, and for six laminates it is 1.7, the rate of increase falling off as the number of laminates increases. This method also allows the fabrication of beams of greater length and cross-section than could be obtained from solid material. In spite of these benefits vertical lamination is seldom used, and the great majority of structural components are laminated horizontally (Fig. 1a).

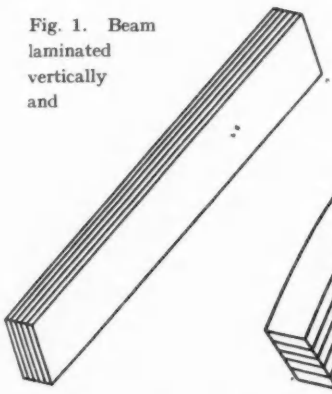


Fig. 1. Beam laminated vertically and

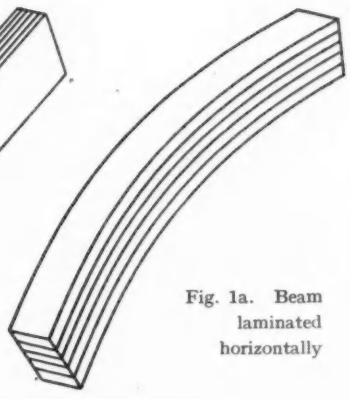


Fig. 1a. Beam laminated horizontally

ADVANTAGES OF LAMINATION

The most important advantage of horizontal lamination is that members may readily be curved. This fact is stressed because it implies a radical departure from the more common type of framed construction. It allows the design of segmental or parabolic arches which are in themselves economical structural forms. It also simplifies the design of fixed joints in such members as portal frames, thereby gaining economy through continuity in the structure. Laminated timber arches and portal frames have an immediate aesthetic appeal which is enhanced by the fine finish which can be given to the material.

Other advantages of horizontal lamination may be summarised briefly. Members may be tapered or moulded to give the greatest strength where it is most needed. Seasoning is relatively easy, due to the small cross-section of individual laminates. Components may be built up to any desired length or cross-section. Material may be chosen which would otherwise be too small to be structurally useful, a special advantage where re-afforestation is producing second-growth timber. Laminated components have a high resistance to fire and are generally considered superior in this respect to exposed steelwork.

ADHESIVE REQUIREMENTS

One of the basic requirements of lamination is that the bonding material must be as strong and durable as the timber itself. For this reason adhesives are much preferred to mechanical fastenings, and the great majority of laminated components made to-day are assembled with some form of glue.

The types of glue most commonly used are the caseins, which are derived from sour milk. Generally speaking casein glues are easy to mix and apply and are not over-sensitive to damp. They make extremely strong joints, but lose much, though not all, of their strength when wetted, regaining it completely on re-drying. Casein glues may also be attacked by micro-organisms, and toxic chemicals are sometimes added to give protection. A good casein glue gives a joint which is strong as the wood itself and can be used with confidence, provided that the structural component is not likely to attain a moisture content of more than 20 per cent. If moisture contents above this figure are expected a synthetic resin adhesive should be used.

The synthetic resin adhesives are comparatively new and have two great advantages. They are extremely resistant to moisture and immune from attack by mould and bacteria. It is true however that the better the performance of a glue the greater care is need in mixing, application and pressing operations.

The synthetic resins are precise chemical compounds and will not tolerate careless handling. Of many types, the best known are those with urea, phenolic and resorcinol bases. They are manufactured as liquids, powders or in dry impregnated film, and may be obtained for use either hot or cold, and may be either thermo-plastic or thermo-setting. These resins have not been in existence long enough to give a positive guarantee of their durability, though certain of them have given completely satisfactory performances under stringent test conditions for a period of more than ten years.

The development of synthetic resins has extended the use of laminated timber far beyond the field of building construction. Components bonded with waterproof adhesives are now being used for ships' timbers, aeroplane parts, motor bodies and a large number of other products.

DESIGN CONSIDERATIONS

Assuming a glue-line which is fully effective, the calculations for horizontally laminated members are very similar to those for solid members. The normal theory of structures is applied and stresses due to bending are assumed to vary uniformly over the cross-section. Safe working stresses are generally the same as for solid timber except that values for tension or compression parallel to the grain may be substantially increased. This is due to the fact that lamination reduces the incidence of defects which affect the whole cross-section. Such increases cannot be applied in bending since the outer laminations then become critical. In bending however, the stresses in the centre laminates are less than in the outer laminates. Lower grade material may therefore be used for the centre laminates, provided reasonable uniformity in denseness and direction of grain is maintained and that a good glue-line can be achieved. American practice is to allow values for the outer laminates to be applied to the whole of a cross-section of which the middle three-fifths are made of timber one grade lower.

For straight members the thickness of laminates is governed only by the need to obtain close contact at the glue-lines, and 2-in. nominal material is commonly used. When members are curved however, the timber must be bent without breaking in a dry state, unheated and with glue applied. The thickness of laminates must therefore be reduced as the radius of curvature decreases. The ratio of the radius of curvature to the thickness of a single laminate should never be less than 100, and for normal purposes a ratio of 150 may be taken as a working minimum. The cost of laminated construction rises as the number of laminations increases, and components with sharp curves are relatively more expensive to make.

*Abstracts from Constructional Research Bulletin No. 5, issued by The Timber Development Association Ltd.

Glued Laminated Timber Structures—continued

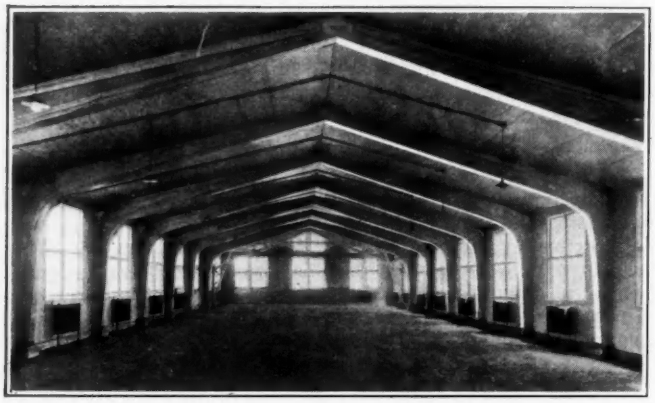


Fig. 2. U.S Forest Products Laboratory Service Building—interior showing glued laminated arches.

EARLY WORK IN EUROPE

The technique of laminating wood has been used for very many years in making furniture, parts of pianos, sports goods and other products. Its application to structures however, is a comparatively recent development which began in Europe before the first World War. The pioneer work appears to have been done by Otto Hetzer, of Weimar, Germany, who experimented with components using casein glue and was successful in obtaining patents for his methods. So-called Hetzer construction spread to a number of countries in Europe, and was most successfully used in Germany, Sweden and Switzerland, with lesser developments in Denmark, Norway and other countries.

An early example in Europe was a plant propagation house built in Switzerland in 1913.

AMERICAN PROGRESS

The first important work on glue laminated structures in America was the erection of an experimental building by the U.S. Forest Products Laboratory at Madison in 1935 (Fig. 2). This building is 46-ft. wide and has nine arches spaced at 16-ft. centres. Five of these arches are of rectangular section, with a maximum depth at the knee-joint tapered to the apex and to the foundations. Two of the arches are made with laminated flanges and double plywood webs, and two are of framed construction with fixed knee-joints. This building was subjected to extensive tests which provided valuable design data.

In 1936 Mr. T. R. C. Wilson, Senior Engineer of the Laboratory, made an extensive tour of Europe to examine the glued laminated structures already in existence at that time. One of his findings was the fact that casein glue had proved to be remarkably durable over a considerable period of years. Mr. Wilson established that in cases where the moisture content of the timber was not allowed to rise above 20 per cent., casein joints gave excellent service over long periods. He also found that casein glue had not been attacked by fumes from coal-fired locomotives when used in railway stations and engine repair shops, and that it had a good record when used in the presence of chemical fumes.

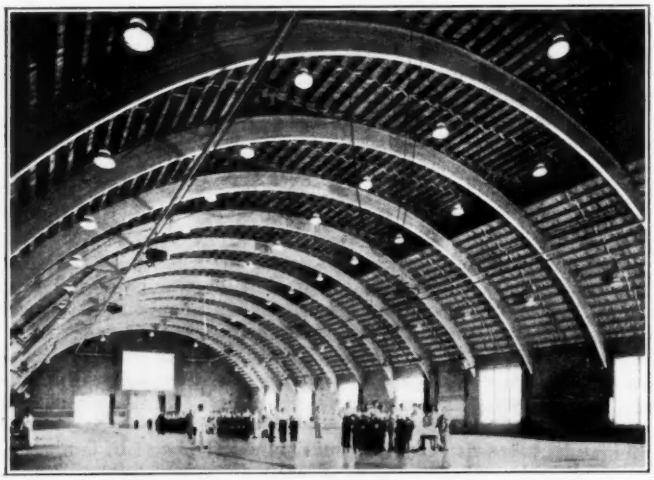


Fig. 3. Laminated construction in Drill Hall at U.S. Naval Training Station, Great Lakes, Illinois.

There is little doubt that Mr. Wilson's findings encouraged the development of laminated structural components using casein glue in the years before synthetic resin adhesives were commercially developed. A church at Minneapolis was built in 1936, using arches of parabolic profile. American designers were quick to see the possibilities of using glued laminated arches in agricultural buildings.

During the second World War the shortage of steel in America led to the rapid expansion in the use of glued laminated construction, made possible by the developments of the inter-war years. In the hands of competent architects the practical and aesthetic possibilities of lamination began to be fully realised. An interesting group of buildings was erected by the U.S. Navy Department at their naval training station at Great Lakes, Illinois. The drill hall in Fig 3 has a clear span of 100-ft. between walls. The arches are approximately 30-in. deep and are carried through the vertical walls into foundations outside the building, so that their actual span is approximately 115-ft. The height of the building is 42-ft. from floor to crown. The arches are made in two halves jointed at the apex with metal plates and timber connectors, and they are braced to one another in their own plane with metal tie rods. A cross-section of the building is shown in Fig. 4.

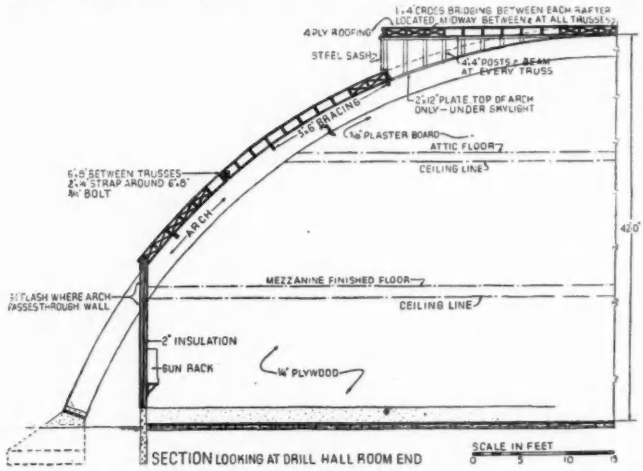


Fig. 4. Cross Section of Drill Hall.

Glued laminated arches have been successfully used in the United States for the construction of aircraft hangars. The Blister hangar (Fig. 5) has a span of just over 100-ft. Still larger arches were used at another air-base spanning 157-ft. spaced at 10-ft. centres. These arches were delivered to the site in three sections and were spliced together with $\frac{1}{2}$-in. steel plates. They rest on splayed concrete foundations so that the thrusts of adjacent arches counteract each other. The structure has longitudinal timber struts of box and I-shaped sections, and additional diagonal bracing rods of $\frac{7}{8}$-in. diameter steel. The sheathing is double boarding, one layer being placed at right angles to the arches and another diagonally. This type of construction results in an extremely rigid shell.

AMERICAN FABRICATION METHODS

Recognised techniques for fabricating glued laminated members have now been worked out in America. The moisture content of the timber is controlled at a figure between 8 and 18 per cent., depending on the service conditions of the component and the

Glued Laminated Timber Structures—continued

type of glue used. To avoid internal stresses moisture content variation between laminates is restricted to 5 per cent. Laminates are machine finished to a smooth surface and sorted for position in the member. The first process of assembly is to join them end to end, which is usually done with a scarfed joint either plain or hooked. Plain scarfs with a slope of not more than 1 in 12 will give full strength values provided they are properly spaced. The hooked scarf which is slightly more difficult to make prevents any tendency of one laminate to ride over the other. Plain butt joints have been used in positions where the stresses are low, but are seldom completely satisfactory. It is almost impossible to maintain the correct radius of the laminate right up to a butt joint, with the result that the efficiency of the glue-line may be affected. If the component is a wide one, laminates may also be jointed side to side to the necessary width.

After end and side jointing the laminates are cleaned up and are then ready for assembly. Some form of jig is necessary for curved members, and this may be arranged vertically or horizontally. With a vertical jig the glue has no tendency to run to the side of the laminate, but horizontal assembly is often more convenient, especially with large components. The jig must be correctly shaped to the profile of the concave side of the member to be fabricated. The first laminate is fastened to the jig and thereafter the remaining laminates are passed through a mechanical glue-spreader and assembled one on top of another.

The pressure required is normally 100 to 200 lb per sq. in. for softwoods, and the best method of obtaining it is by means of closely spaced clamps. The clamps, which are often used with wood or metal cauls, may be spaced as far as 15-in. apart, but on curved surfaces they may be as close as 4-in. Pressure is maintained from six to twelve hours, depending on the type of glue and the shop conditions. Another method is to nail each laminate in turn and so avoid the use of large numbers of clamps. But it is now considered doubtful if nailing produces sufficient uniform pressure and the technique is no longer recommended except in special circumstances. When the component has been removed from the jig the edges and ends are finished and a moisture seal is applied. To protect their finish, components are sometimes carefully wrapped in waterproof paper which is left in place until after erection.

BOWSTRING ROOF TRUSSES

Before leaving American developments in lamination, special mention must be made of the Bowstring type of truss. This is a modern equivalent of the traditional Belfast truss and provides a far more efficient structural unit. Basically a bowstring truss consists of a curved laminated top chord with the main tie and bracing members of solid timber. The top chord and main tie are generally double the bracing members being placed between them and the joints made with timber connectors. The shape of the truss is such that a very large proportion of the forces is carried by the top chord and the main tie, and unless the truss is asymmetrically loaded the forces in the bracing members are small. The thrust of the top chord at the eaves is taken by a metal shoe which passes round the end of the main tie.

Since the radius of curvature of the top chord is large, 2-in. nominal laminations are commonly used. The chord may be continuous over the whole span or may be made in sections and splice jointed on the site. Some American details have shown $\frac{1}{2}$-in. diameter stitch bolts through the laminates at every joint in the top chord. These were provided as an extra precaution due to lack of confidence in the adhesives used, but experience has since proved them to be unnecessary.

The site photograph (Fig. 6) shows the erection of bowstring trusses spanning 111-ft. The top chords of these trusses are spliced at the crown, and the main tie has been given a slight camber. The trusses carry purlins at 2-ft. centres, on which diagonal boarding and felt are laid. Bracing between the trusses is provided at two points on the span. Bowstring roof trusses are popular in America, where they are considered to be one of the most economical forms of construction for wide spans of 80-ft. and upwards.

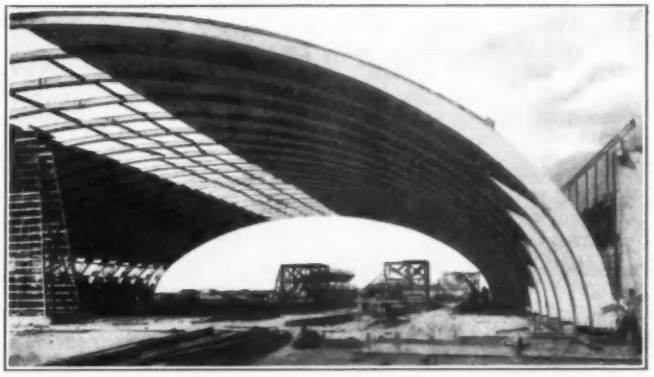


Fig. 5. Glued laminated arches of 100-ft. span—Blister Hanger.

SWEDISH TECHNIQUES

In Sweden there are two principal firms engaged on laminated construction on a large scale. Their methods are different, and between them they have established lamination as a recognised technique for very many types of buildings. The first is AB Fribärande Träkonstruktioner of Töreboda, which began operating under Hetzer patents in 1919 and has continued ever since. This firm produces predominantly deep members of I-section laminated horizontally. The webs are first assembled and the flanges which are of wider material, are then added. The stiffeners are made of short sections with the grain parallel to that of the web members. This is done to avoid the shear stresses which would be set up by changes in moisture content if the grain of the stiffeners were at right angles to that of the web.

Before the second World War the Töreboda firm were using the technique of nailing each successive lamination to provide the gluing pressure. The tendency now, as in America, is to use more clamps and fewer nails in assembly. Scarfs are generally hooked, which makes it possible to end-joint the laminations as the work proceeds, since quick positioning of the joint is ensured, and the laminates have no tendency to ride over one another. Töreboda construction has a high reputation for good workmanship and fine finish, and has been used in railway stations, factories, warehouses, gymnasia, barns, hangars and many other types of building.

A typical example is the tennis hall at Alvik where these arches span 145-ft., providing unobstructed floor space and ample headroom. Spans up to 216-ft. have been constructed on similar lines Töreboda construction has also been adopted by the Swedish State Railways, the largest example being the Central Station at Stock-

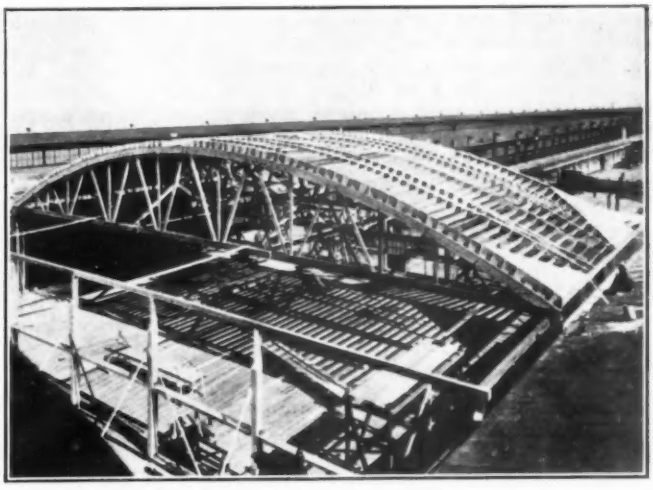


Fig. 6. Erection of 111-ft. span Bowstring roof trusses.

Glued Laminated Timber Structures—continued

holm. Many smaller stations have cantilever platform roofs.

The second Swedish firm is AB HSB Boro of Stockholm, which started work in 1939 and has already provided components for over 1,500 structures. The " HB " system designed by this firm is mostly used for buildings in which a high standard of finish is not essential, and it is somewhat cheaper than Töreboda construction.

The webs of HB units are made with 1-in. thick boards placed diagonally in two layers approximately at right angles to one another. Originally the flanges were made from poles cut down the centre, but it has since proved difficult to obtain this material of the right size and in the right lengths. Flanges now consist of rectangular laminated sections built up from 1-in. thick material and scarfed end to end to the required length. These flanges are fixed to the web with a carefully-calculated system of nailing, which also provides the only connection between the two layers of the web. The assembly of HB components is therefore very simple. Calculations are made on the assumption that the flanges take all the bending moment on a member, and the web all the shear forces. Since the web planks are placed in the planes of principal stress they normally have only tension or compression induced in them.

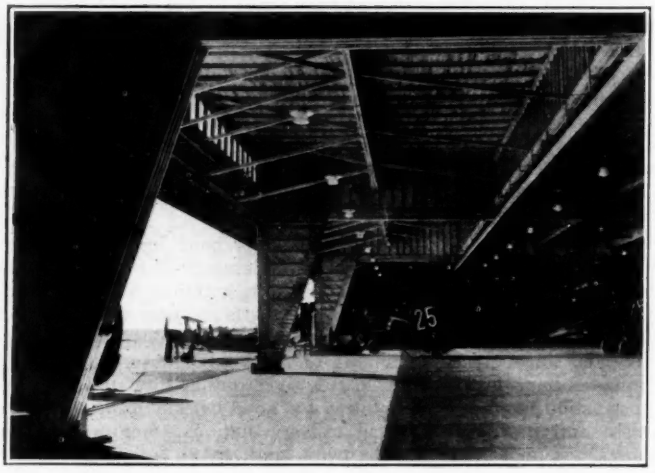


Fig. 7. Swedish Air Force hangar of HB construction with primary portal frames spanning 115-ft.

The HB system is very suitable for the construction of portal frames and is often used in this way for agricultural buildings. The rigid knee-joints in this type of component are usually made on the site. Frames of a similar type are used in the games hall built for the Swedish Navy of which the span is nearly 100-ft. In this case the webs of the frames are provided with stiffeners and metal plates are used to make the connections at the apex. HB construction has also been adopted in more than 75 per cent. of the aircraft hangars built in Sweden during the war. The Swedish Air Force hangar (Fig. 7) has primary portal frames spanning 115-ft. and secondary beams spanning 72-ft. For buildings such as this laminated construction is favoured for its superior fire resistance, and is often used in conjunction with light-weight concrete slabs. The HB system is also applied to beams in factory floors and bridges. The bridge over the river Biskan at Rydal has four HB beams which are continuous over their supports with a central span of 65-ft. and two side spans of 50-ft. For this type of exposed structure the timber is preserved with an arsenic compound, and further protection is provided by covering the top flanges of the beams with bituminous felt.

PRACTICAL CONSIDERATIONS

When choosing glued lamination construction for buildings there are certain practical considerations to bear in mind. One is the question of cost. It has not been found possible to make a structural unit by lamination as cheaply as in solid timber. But lamination serves many functions which cannot as readily be met by other methods. Its cost may therefore be justified either by greater efficiency or improved appearance. The attractive profiles of laminated components have often encouraged designers to leave them exposed to the interiors of buildings. In some cases this has resulted in a saving on the total cost of construction since it has made the use of suspended ceilings unnecessary. Lamination involves more machining than solid construction since each laminate must be given smooth finish. This factor may be offset by the inherent efficiency of the arches and rigid frames which are made possible by lamination.

Douglas Fir and Yellow Pine are the species most commonly used for lamination in America, and the qualities called for are generally at least as good as those normally used for structural purposes. It is sometimes held that the lower stressed parts of laminated members might be made from very poor quality material, but in practice this is not satisfactory. Many large knots and other defects make the timber difficult to machine, less easy to bend, and may result in imperfect glue lines. Nor is it desirable, except in special circumstances, to go to the other extreme of insisting on almost clear material. The greatest economy can be achieved if the quality of the product is carefully gauged to suit the function of the building.

Facilities which are needed for the production of laminated components include a drying kiln, or easy access to one, and suitable storage, preferably under controlled conditions. Space is needed in which to erect jigs or beds, and the equipment required will include means for testing moisture content, machinery for end scarfing and mechanical glue spreading, and a suitable supply of clamps, cauls and torque wrenches for assembly. Personnel engaged on lamination require some knowledge of selecting material and a capacity for accurate machine work.

THE POSITION IN GREAT BRITAIN

Structural simplicity is perhaps the characteristic of laminated construction which makes the most immediate appeal to the designer of buildings. In solid timber he has a material which already combines lightness with great strength. Lamination sets timber free and allows the designer to mould it to the dimensions and shape best suited to his purpose. The resulting structural forms are clean, efficient, and often beautiful.

At the present time there are few buildings to be seen in Great Britain which make use of up-to-date glued laminated technique, but development work is proceeding on its application to bowstring trusses, agricultural buildings and commercial glasshouses. There is reason to believe that the advantages of lamination are becoming more widely appreciated and as the supply position improves there is little doubt that it will be used in an increasing number of buildings.

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The Danish Westcoast

Littoral Drift Problems and Measures against Coast Erosion

By PER BRUUN.

THIS article applies to the part of the Westcoast—212 miles in extent—situated between the Scaw, the most northerly point of Jutland, and Blaavands Huk, the most westerly point of Jutland (see Fig. 1). The coast is washed by the North Sea and the Skager Rack. The boundary between the two seas is the line running from Hanstholm in Denmark to Lindesnæs in Norway.

The Westcoast is a "weak-material-coast" consisting mainly of sand, and so it presents a smooth and plain coast-line, shaped by the action of waves and currents. The most frequent and strongest winds are those from the western quadrant, which have consequently shaped the coast. The characteristic gale will start from the south-west with a force of 4-6 Beaufort, after which in the course of 12 to 14 hours it will, with increasing force, 6-9 Beaufort, veer to the west or the north-west as far as the southern part of the coast is concerned, where the wind remains for 2 to 3 days or more. The water often begins to rise when the barometer falls, even before the gale has started, because the water from the English Channel is forced into the North Sea through the Straits of Dover. When the wind has turned to the north-west, the water falls. The tidal range at Esbjerg is about 4½ feet, at Hvide Sande about 2 feet, at Thyborön about 14 inches, and at the Scaw about 10 inches. Heavy westerly gales may cause a high-water of 10 to 13 feet at Esbjerg, 7 to 8 feet at Hvide Sande, at Thyborön about 5 to 6 feet, and at the Scaw 3 to 4 feet. The wave-height is greatest at the North Sea coast, about 10 feet during heavy gales, but breakers along the coast may reach a height of 15 to 16 feet.

On the part of the coast-line between Blaavands Huk and Lodbjærg, which takes an almost north-south direction, we find the inlets closed by barriers: the Ringkobing Inlet, the Nissum Inlet, and the Lime Inlet. Between Lodbjærg and the Scaw the coast is, as it were, suspended from hooks, formed by the headlands: Hanstholm (chalk and moraine 160-ft.), Bulbjerg (chalk and moraine 160-ft.) and Hirtshals (moraine 100-ft.), and a few smaller headlands. Between these the coast is smooth and plain. As a result of the action to which they have been exposed, the headlands are almost identical in shape and position. The angles on the coast-lines being everywhere between 100 degrees and 120 degrees, the shape of the coast has a mature appearance.

The height of the Westcoast is generally 15 to 17 feet above Danish Normal Zero (D.N.N.-M.L.W.), the height of the barriers is, however, only 3 to 6 feet, wherefore they are protected from the sea either by dunes or by artificial dikes. Besides the headlands already mentioned, considerable moraines are found at Bovbjærg (130-ft.), Lodbjærg (100-ft.), and Rubjærg (230-ft.).

It looks as if the littoral drift, which is closely following the coast owing to the action of waves and wave-streams, from a point near Lodbjærg takes a northward direction, i.e., towards the Scaw, whereas to the south of Lodbjærg, except for a short distance along the Southern Lime Inlet Barrier (see later), it takes a southward direction, i.e., towards Blaavands Huk. In Denmark we call Lodbjærg a "Zero Point," but in England they would call it a "Neutral Point."

The drifting material consists mainly of sand (about 0.008 inch mesh) and small quantities of gravel (1 to 2 inch mesh), the size of the grains decreasing towards the extremities, Blaavands Huk and the Scaw. North of Blaavands Huk there are generally two off-shore bars; between the Nissum Inlet and Hanstholm only one, which is moreover badly developed out of the Lime Inlet Barriers. Between Hanstholm and the Scaw there are generally two or three off-shore bars; at the Scaw, where the littoral drift is maximum, even three or four bars. Owing to the off-shore bars the western coast of Jutland is very dangerous to navigation, wherefore national life-boat stations are found in numerous places. Practically no seaweed is found on the Westcoast. About the littoral drift occurring at greater depths, caused by the action of waves and sea currents, nothing is known; but because of the prevailing north-easterly currents, which are a result of the westerly winds, a drift of small-sized material is probably taking place from the North Sea to the deep water of the Skager Rack, where the material settles.

The coast between Lodbjærg and the Scaw is, with the exception of certain short stretches, especially to the north, fairly stable,

Fig. 1. Map of Denmark.

because the headlands already mentioned moderate any possible changes of the coast-line.

Works of coast protection of any importance have not been constructed in the said area until recently. Only in 1949, six groins were constructed at the Old Scaw (Fig. 1), 170-ft. in length and spaced 270-ft. apart, consisting of a wall of wooden piles with "seastone" (stones from glacial times picked up from the bottom of the Kattegat) heaped along the sides, combined with a lateral work glacis built of seastone supported by wooden piling. The eroded material is carried along the coast to the north, and it is probable by far the greater quantity is deposited north of the Scaw on the long reef (Skagens Reef), which projects 2.5 miles to the north-east into the sea. The reef is built up of smooth, white sand. Consequently the spit of the Scaw is annually shifted 4 to 5 yards to the north. At Hirtshals a harbour covering a water area of 46 acres was finished in 1932. The harbour serves as a fishing-harbour and since the war is used by the liners for Norway (Kristianssand) during the summer months only. The Norway liners require a depth of about 23-ft. at the entrance to the harbour, but the maintenance of the depths has involved great difficulties owing to the strong north-easterly littoral drift, and it looks as if

The Danish Westcoast—continued

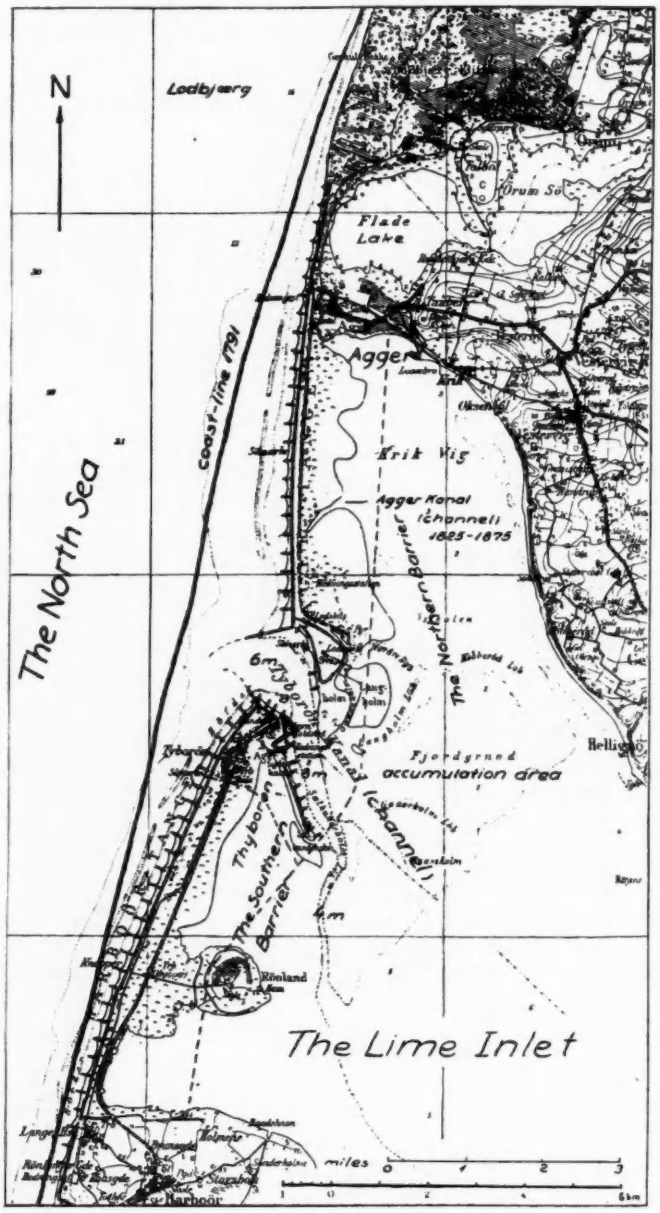

Fig. 2. The Lime Inlet Barriers.

these difficulties are likely to continue with the present dimensions of the jetties. At the headland of Hanstholm the construction of a harbour has been started, but it looks as if the maintenance of the depths may be troublesome.

As mentioned before, the littoral drift from and south of Lodbjærg takes a southward direction. The coastline has retired very considerably at the Lime Inlet Barriers about Thyboron, where special conditions connected with the bar-breach have made themselves felt (see later). Before the groins were built at Bovbjærg, the coastline annually retired about 2 yards on an

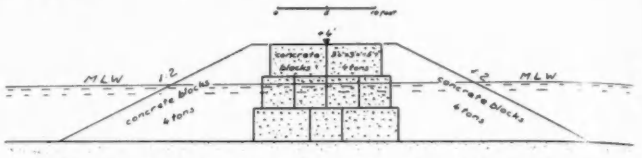

Fig. 4. Cross Section of Groin, The Lime Inlet Barriers.

average calculated over a considerable number of years. The erosion decreases towards the south until in the Holmsland area (Ringkobing Inlet) it is zero. From this point towards Blaavands Huk, we find a growing tendency to accretion, which makes the coast turn slowly to the south-west. During the period 1870-1950, Blaavands Huk has thus been shifted about 1,200 yards to N.N.W., viz., 15 yards a year (cf. the development of Dungeness in Kent). The movement of the coast must undoubtedly be considered from a geological point of view, according to which the 25 miles of Horns Reef, which is probably the remnants of a marginal moraine, must be supposed to play a great part as a sheltering wall as well as a material-stopping wall. Thus it looks as if great quantities of the sand material eroded on the southern part of the North Sea coast are deposited at Horns Reef. Various circumstances, however, indicate that considerable quantities of small size sand are carried over the reef, after which it drifts further to the south along the peninsula of Skallingen, contributing to the great difficulties connected with the maintenance of the fairway of Graadyb, which has a depth of 27 feet leading to the harbour of Esbjerg, the important outport for agricultural produce to England. About 1 million cubic yards are dredged every year.

Very considerable works of coast protection have been carried out from Lodbjærg to a point about 13 miles to the south, except for a distance of about ½ mile at Thyboron Channel. Fig. 2 shows the cut indicated in Fig. 1. The figure comprises principally the two barriers (½ to 1 mile in width) which separate the North Sea from the Lime Inlet. The barriers are built up of sand to a level of 20-ft., and then a weak inlet deposited Litorina clay (shear 600 to 800 lbs. per foot^2). On the point of the Southern Barrier lies a fishing harbour, Thyboron (about 2,000 inhabitants), whose fishing boats sell a considerable part of their hauls of fish to Hull and Grimsby (their index mark is L). In Fig. 2 is shown the position of the coastline in 1791, when the barrier was unbroken, and that of the coastline of to-day. The existing open channel was formed by bar breach in 1862. Several channels existed before that time, for instance, the Agger Channel (see Fig. 2), closed by nature in 1875. Historical accounts suggest that in the 11th century the Lime Inlet had an open and good connection with the sea, through which the Viking raids on England passed. On account of trading interests, fishing and shipping, the State has maintained the channel by extensive protecting and regulating works, groins and dikes (see Fig. 2). The latest measures in this respect are embodied in the Act of August, 1946, which provided for the construction of two big jetties, one on each side of the channel, and a new solid dike about 1½ miles from the sea. The dike will be built across the channel as a dam with sluices. The new project, which has just been commenced, is indicated by dotted lines in Fig. 2.

Immediately after the bar breach the barriers began curving inwards towards the channel, so that to-day the coast at Thyboron is situated about 1¼ miles farther landwards than in 1791. The curving of the barriers is caused by the coast erosion in connection with the difference in water level (up to about 5-ft.) between the sea and the inlet prevailing during westerly gales, the result of which is that the water with its contents of suspended material is sucked into the inlet, where the solids are deposited in large shal-

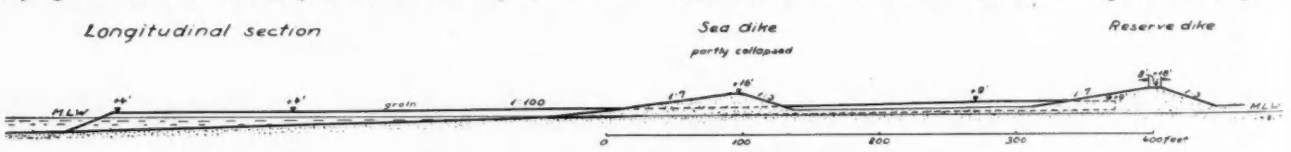

Fig. 3. Coast protection, The Lime Inlet Barriers.

The Danish Westcoast—continued

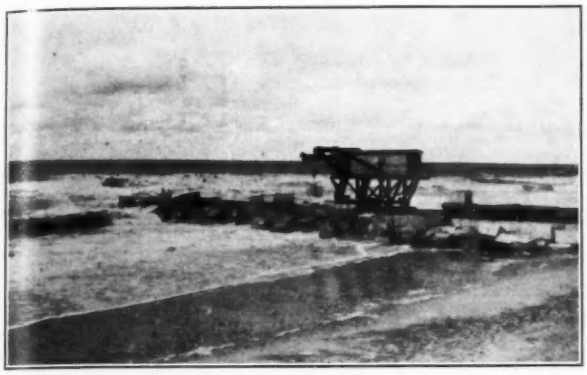

Fig. 5. The crane at work. The Southern Lime Inlet Barrier, 1948.

lows (see Fig. 2). At present about 1 million cubic yards of sand are deposited annually, whereas the annual average erosion of the barriers is 1½ to 2 yards on the Southern Barrier and 2 to 3 yards on the Northern Barrier. During strong westerly gales the current in the channel may acquire a speed of about 10-ft. per second. The mean depth of the channel has been stated in metres in Fig. 2.

Until now the coast protection works, which are to be described in the following, have comprised the construction of dikes and groins. During the period 1875-1910, thirty groins were built on the Southern and twenty-five on the Northern Barrier, besides the big dikes (shown in Fig. 2) and the groins and dikes constructed along the channel. All these works and the harbour at Thyboron are financed, built and maintained by the Danish State (the Ministry of Works), acting through " Vandbygningsvæsenet " (Lemvig District).

The dikes are to protect the barriers from wash-outs, and the groins are to check the littoral drifts, which for a distance of 5 to 7 miles on both sides of the channel is going in the direction of the latter. The space between the groins is about 1,250 feet, and the length of the groins is 700 to 1,300 feet, generally increasing towards the channel. The last groins on both sides of the channel are reinforced and built out as jetties of 1,400 feet and 3,000 feet respectively (see Fig. 2). The groins are not maintained in their full lengths any more, as on account of the continued erosion they had gradually become too expensive, and therefore 200 to 400 feet of the end farthest from the coast have been abandoned.

The construction of the groins and the dikes have been gradually developed and improved by the Lemvig District. Fig. 3 shows a

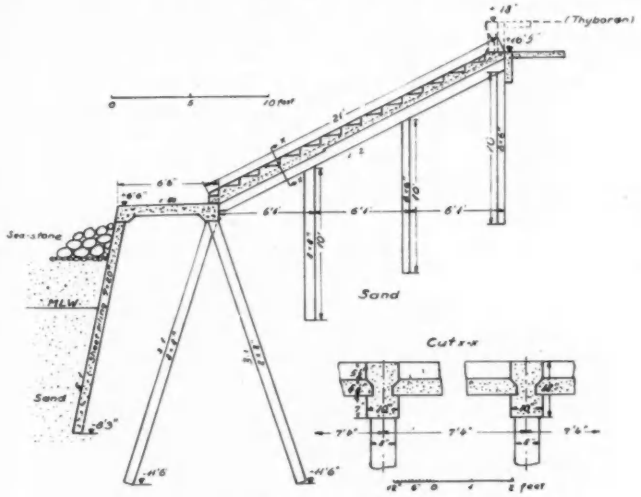

Fig. 6. Cross Section of Lateral Work, Agger.

longitudinal section of the coast protection of the Southern Barrier, which, like the Northern Barrier, has a " sea dike " and a " reserve dike " of the dimensions stated in the figure. On the dikes, which are built of sand, is planted marram-grass (16 tufts of three to four plants per square yard). In England, often only four tufts per square yard are planted. The dikes are built by excavator or by hand power. The longitudinal section shows a groin, too. The height (4-ft.) of the outer end has been chosen for constructional reasons.

Fig. 4 shows a cross section. The groin is built of a core of piled-up blocks of concrete—the " crown "—with blocks of concrete and seastone heaped along the sides. The weight of a block is 4 tons, the volume 62 cubic feet, and dimensions of 3-ft. 4-in. × 3-ft. 4-in. × 5-ft. 9-in. Each block contains 8 cwt. of cement, 53 cubic feet of gravel (taken from the foreshore), 28 cubic feet of sand (from the foreshore or screened from a gravel

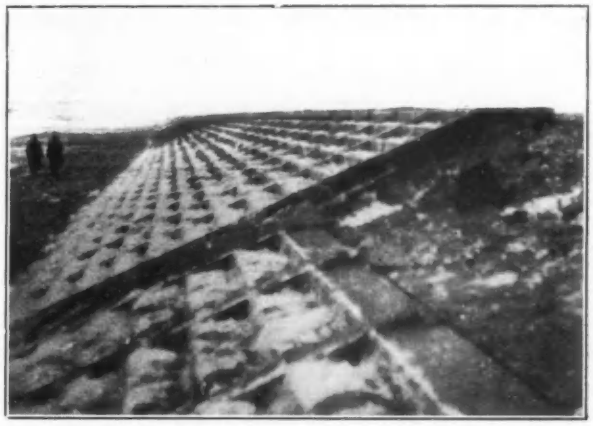

Fig. 7. The Lateral Work at Agger.

Fig. 8. The Lateral Work at Dymchurch, 1949.

pit), and 50 gallons of water is used, with labour of 6 to 8 working hours. The blocks are cast by means of a concrete-mixer in a working place nearby. They are rammed or vibrated carefully and are kept wet after the casting. The block is cast with a hooked iron bar in it, which is used for slinging when the block is being placed in the groin. The cement used is a sea-water cement specially produced by the Danish cement factories. The " sea-water cement " is a type of Portland cement specially manufactured to withstand the influences to which the concrete is exposed in sea-water, specially the deteriorating effect of sulphates. The use of sea-water cement has just begun. As yet, we have seen no results regarding sea-water cement.

The blocks are taken to the groin on trolleys and put in place by means of specially designed self-propelled cranes running on 100 lb. rails laid out on sleepers attached to the block-hooks. The cranes are designed to carry 10 tons, so that they may also be used for handling 8-ton blocks, which are used only in exposed

The Danish Westcoast – continued

places of the groins. Fig. 5 shows the crane in function. The latest type of crane is a portal swing crane. At the "land-ends" of the groins, where the cross section consists of three "crown-blocks" only, the block is often cast in the groin itself.

The type of groin used is called an "after-filling" groin. The material required for the construction of a groin 700-ft. long, about half of which is situated within the coastline, consists of approximately 3,000 pieces of 4-ton blocks, and at the present time costs £20,000-25,000. The weakness of the groin is that it gradually sinks, for which reason it must be re-heightened, generally within a cycle of 10 years. This consists in re-dressing of the crown and supplementing of the concrete blocks or seastone along the sides.

A glacis of reinforced concrete, 400 yards in length, has been built on the outer slope of the dike north of Agger (the Northern Barrier) for a distance of about 1 mile off Flade Lake and for a distance of about 400 yards at Thyboron Town. (Fig. 6 shows the cross section of the glacis off Flade Lake, photograph Fig. 7.) The design used has not proved very durable in places, partly because the sheet-piling was not tight, and partly because the waves

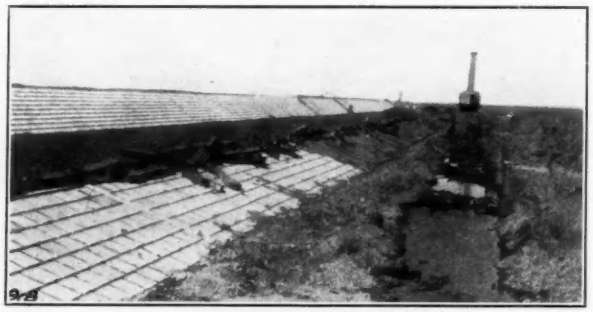

Fig. 9. The Lateral Work at Pett Level under construction, 1949.

Fig. 10. Dike breach. The Southern Lime Inlet Barrier, 1948. On the foreshore are seen some German pillboxes built into the dike in 1944, now gone to sea.

swept over it and washed away the sand behind and under the glacis. The experiences here have been utlized in the construction of the later lateral work of the same type at Thyboron. The latter is provided with a wave-screen (shown in dotted line in Fig. 6.)

Figs. 8 and 9 show corresponding English constructions from the Channel, namely from Dymchurch (Kent Rivers Catchment Board) and from Pett Level (Rother and Jury's Gut Catchment Board). Neither the English nor the Danish construction, however, offers an adequate protection of a coastline subject to continual erosion like the Lime Inlet Barriers Coast. If the lateral work here is not moved inwards, it will sooner or later collapse. Fig. 10 shows a breach in the sea-dike of the Southern Barrier in October, 1948, at a place where the dike was very weak and excavated (because of the construction of the reserve dike).

German pill-boxes, built in the dike in 1944, were washed free and sunk.

Fig. 11. Coast erosion south of Bovbjærg, rough weather, Trans church, 1949.

The groin construction described has also been used at Bovbjærg and north of Bovbjærg, where 23 groins 500 to 700 feet long, spaced about 1,250 feet apart, were built during the period 1875-1937.

The coast erosion, which immediately before the groin building at Bovbjærg was about 10 feet a year, is now less than 3 feet. The soil is moraine clay and is classed among the best arable land in Denmark. On the lee side of the group of groins (the south side) a very severe erosion has taken place in the 30 to 40 feet high, rather sandy coast. The erosion has been 20 to 25 feet a year during the last 10 years. Fig. 11 is a photo of this country taken south-north. In the background is seen the most southerly groin of the Bovbjærg-group and the old Trans church, a typical Danish village church in Roman style (granite), probably built in the 11th or 12th century, though the tower is not so old. The church stands 90 yards from the top of the slope. Fig. 12 shows coast erosion at S. Yorks, near Shipsea. The average withdrawal of the coast is here, according to J. A. Steers: "The Coastline of England and Wales," about 2 yards a year.

South of Bovbjærg are two small groups of five groins each. Here a block-construction with a central wooden sheet pile wall has been tried, but so far this type does not seem to be an improvement of the pure block-construction.

To protect the sand barrier, about ½-mile wide and about 10 miles long, in front of Nissum Inlet from over-topping, a dike has been constructed 3,000 yards from the coastline, which retires nearly 2 yards a year. The upper level and width are 16-ft. 6-in. and 6-ft. 6-in., the sea side slope is 1 : 7, and the land side slope 1 : 3. At Thorsminde the outflow from the inlet is covered by two jetties built of concrete blocks, 300-ft. and 500-ft. in length respectively, and by four groins, two of which (650-ft. long) are situated north of the outflow and two (350-ft. long) south of the outflow. The outflow is provided with a sluice, which was built in 1868-70

Fig. 12. Coast erosion. South Yorks, 1949.

The Danish Westcoast—continued

by English engineers during an attempt to dry up part of the "Fjord." There is also a fishing harbour navigable for boats of up to 10 G.R. tons.

At Husby, south of the Nissum Inlet, is a group of 12 smaller groins built of concrete blocks. The sand barrier, 1 to 1½ miles in width and 20 miles in length, in front of Ringkobing Inlet is unprotected, as the coastline seems to be in a state of equilibrium. The outflow at "White Sands" (Hvide Sande) is protected by two jetties, 650-ft. long, built of concrete blocks. The outflow is provided with sluices, and there is a fishing harbour for boats of 10-20 G.R. tons.

Between White Sands and Blaavands Huk there is no coast protection, as the coast is in a state of equilibrium or advancing. To the south-east of Blaavands Huk, on the peninsula of Skallingen, where the coastline is retiring, some small groins of wooden sheet piling have been built.

South of Blaavands Huk are the islands of Fano, Mano and Romo, and between them and the mainland is the Danish marsh sea of a nature similar to that of the adjacent German and Friesian coasts.

By the above description, I hope to have conveyed a clear impression of the Danish Westcoast and its coast problems.

Obituary

Brysson Cunningham D.Sc., B.E., F.R.S.E., M.I.C.E.

It is with great regret that we have to announce the passing of Dr. Brysson Cunningham, the late Editor of this Journal, who died at Eastbourne on the 31st July last, aged 81 years.

Born in September, 1868, Brysson Cunningham received his education at Liverpool College Middle School, and thereafter was apprenticed, at the age of 15, to a firm of Liverpool Architects and Surveyors. Scarcely had he completed the term of his articles when he obtained a position as draughtsman in the engineering department of the Mersey Docks and Harbour Board. During the 16 years of his service with the Board, he was mainly employed on the construction of important new dock installations and port improvement works at the North End of the Liverpool Estate which involved an expenditure of over 3 millions sterling. In 1906 he was successful in his application for a Resident Engineership under the London and India Docks Company, and when the Port of London Authority came into existence in 1909, Mr. Fredrick Palmer, afterwards Sir Fredrick Palmer, K.C.M.G., appointed him as his Personal Assistant at a time when schemes of great magnitude for the development of the River Thames and the Port of London were in preparation, including the King George V Dock of 65 acres, with an 800-ft. Entrance Lock and a 700-ft. Graving Dock. The whole programme of works was estimated to cost about 4 million pounds.

In 1921, he left the service of the Port of London Authority and joined Mr. A. Havelock Case, Wh.Sc., M.I.C.E., in partnership in Westminster under the style of Case and Cunningham, Consulting Engineers, and was engaged on a number of riverside schemes and maritime works, including harbour works at Montevideo. The partnership being dissolved in 1930, Dr. Cunningham continued to practice alone, acting as consulting engineer to a number of public bodies, including the Dartford and Crayford Navigation Commission, the Canvey Island Commission, the Dartford Commission of Sewers (the old English term for watercourses), the Darenth Valley Main Sewerage Board, the Gosport Borough Council, the Waterford Harbour Commissioners, etc. He retired from active professional practice in 1940.

While in the service of the Mersey Docks and Harbour Board he had, by private study, graduated in the Royal University of Ireland (Dublin) as Bachelor of Engineering, gaining honours and an exhibition. In 1915, having transferred to Queen's University (Belfast), on the dissolution of the Royal University, he qualified by examination for the further degree of Doctor of Science. In the same year he was elected to the Fellowship of the Royal Society of Edinburgh. He also (1897) acquired membership of the Institution of Civil Engineers, London. He was a bronze medallist of the City and Guilds of London Institute (1899) and in 1923 received the Broodbank Gold Medal of the Institute of Transport for a paper on Methods of Cargo Handling at Ports. He contributed papers on maritime subjects to several international Congresses and was the writer of over 200 articles in the scientific and technical press. He delivered lectures, by invitation, to the Royal Geographical Society, the Institute of Transport, and the Institute of Civil Engineers (Vernon-Harcourt Lecture 1937).

From 1921 to 1936, he was Lecturer on Waterways, Harbours and Docks at University College, London, and from 1936 to 1938 Lecturer on Port Planning at the Architectural Association's School of Planning and Research for National Development. From 1907 to 1921 he was a member of the Advisory Committee of the L.C.C. School of Engineering and Navigation, Poplar, and from 1917 to 1921 its Vice-Chairman. He was co-opted for 5 years (1916 to 1921) on the Examination and Awards Committee of the Institute of Marine Engineers and for 15 years (1923 to 1938) on the Education and Examination Committee of the Institute of Transport, for which body he acted as Examiner on Ports and Inland Water Transport subjects from 1929 to 1942.

For several years he was actively connected with the British Association as a member of the General Committee, and from 1932 to 1935 he served on a special Research Committee appointed "to enquire into the position of Inland Water Survey in the British Isles and the possible organisation and control of such a survey by central authority." The Committee was instrumental by means of a thorough investigation and painstaking Report in inducing the Government in 1935 to appoint an official Committee to advise on the Inland Water Survey of Great Britain. The covering communication to the Prime Minister submitting the Report, which was signed by Sir H. H. Jeans, President of the British Association and Sir Henry Maybury, President of the Institution of Civil Engineers was prepared by Dr. Cunningham, who also contributed a main memorandum among the appendices to the Report.

His association with *The Dock and Harbour Authority* at its inception is described in the October, 1945 issue of the Journal. He acted as Editor from its foundation in 1920 to 1926 and again from February 1937 to March 1946, 16 years in all.

A list of his published works is as follows:

Text Book on Building Construction (3 editions).
Principles and Practice of Dock Engineering (3 editions).
Principles and Practice of Harbour Engineering (3 editions).
Dock and Harbour Engineer's Reference Book (2 editions).
Cargo Handling at Ports (2 editions).
Port Administration and Operation.
Port Economics.
Port Studies.

Dr. Cunningham travelled extensively in Europe, visiting all the leading ports in the Mediterranean, the Baltic and the North Sea and in the United States and Canada. In 1922 he gave addresses to the American Association of Port Authorities at Toronto, to the Society of Terminal Engineers at New York and the Engineers' Club at Philadelphia. He paid a second visit to North America in 1927.

Some Modern Cargo Handling Appliances

(concluded from page 158)

physically arduous, but some machines displace labour. In post-war years particularly—due to the introduction of the labour de-casualisation scheme—the working conditions of the British docker have improved so much that he has taken his place among the better-paid workers of the community. Nevertheless, although employers and unions alike would agree that there is a balanced gang—i.e., a correct number of men—for each mechanical operation, there is still a long way to go before both parties see eye to eye on the labour aspect of mechanisation.

The next and final article of this series is entitled "The Manning Problem" and discusses the questions of labour displaced by the new machines and the sharing of benefits deriving from their use. The first stage in the solution of this problem has been reached—for there is already frank recognition and acknowledgment by both parties that it exists.

Publicising English Canals

Rally of Boats at Market Harborough

(By our Special Correspondent)

A most successful function which has drawn much attention to the Inland Waterways of England, and also to the comparative disuse by commercial traffic to which they have sunk, was held at Market Harborough, Leicestershire, between August 14th and August 19th, 1950.

This event, which was organised jointly by the Inland Waterways Association and the Market Harborough Urban District Council, was primarily intended to satisfy the increasing number of pleasure boat users who enjoy the facilities of the canal system, but at the same time it has attracted a surprising and gratifying amount of attention in the press and from the public generally. Interest in the programmes centred round the rally of boats as such, and the various awards offered for meritorious journeys, and for the condition and design of the boats which attended, in addition to which exhibitions and entertainments were available in the town. These included the films "Painted Boats" (Ealing Studios Production) and "Inland Waterways" (kindly provided by the Docks and Inland Waterways Executive), and exhibitions of paintings, photographs, models and samples of the traditional decorations usually seen on narrow boats.

Market Harborough was a particularly good choice for a rally of boats, since it lies at the end of a branch canal, and the congregation of boats there interfered as little as possible with the normal commercial traffic. Altogether about 150 boats of various types attended the rally and were moored in the basin and along the towpath. During the week the towpath was thronged with visitors inspecting the wide variety of boats assembled, and it would be difficult to assess the publicity value of the event. The total number of visitors has been estimated at fifty thousand, and there is no doubt that many more people will now be aware of the facilities for inland water transport which exist in this country.

Perhaps the greatest attraction was created by the various working narrow boats which had arrived to compete for the "Knill Cup," to be awarded for the best maintained trading boat. Amazement was expressed at the care and attention lavished by their captains and crews upon these boats, which are normally occupied in coal traffic, and great interest was shown in the outcome of the competition. Furthermore, this competitive spirit will have done much to encourage a high standard amongst captains and to improve morale in this branch of the waterways industry. The trophy was presented by Mr. John Knill, who arrived with the working boats of which he is the owner-captain, and the adjudication was undertaken by him in collaboration with the Earl of Lucan, who travelled in his monkey boat, "Hesperus". Competing boats were released from regular duty for this event by the Docks and Inland Waterways Executive ("British Waterways"), Messrs. Samuel Barlow Coal Co., Ltd., Messrs. A. Wander, Ltd. ("Ovaltine"), and Messrs. S. E. Barlow. It was a pity that no representative ex-Fellows, Morton & Clayton boats were present, nor any typical narrow boats from the Potteries.

In announcing that the winner was Mr. Arthur Stokes, captain of the "Ovaltine" pair of boats, Mr. Knill stated that the competition was so keen that the Earl of Lucan had presented a further prize for the runner-up, Mr. Alfred Best, captain of the "British Waterways" boats.

Another attraction provided by trading boats, which is of particular interest to readers of this Journal, was the daily pleasure trips to Foxton and back. The public were able to enjoy the experience of travelling a total of twelve miles along the canal and also of inspecting the ten locks at Foxton and the remains of the inclined plane lift which was built early in this century and abandoned shortly afterwards. These trips were undertaken in a pair of boats kindly lent by Messrs. Samuel Barlow Coal Co., Ltd., and steered with great skill past the throng of other boats by Mr. and Mrs. George Smith. The question of whether canals can be used for pleasure purposes without interfering with commercial traffic is a very difficult one, added to which is the fact that lightly built pleasure boats are liable to damage if they are not steered with sufficient skill to avoid collision, but there seems no such objection to the use of trading boats for outings of this sort, in the hands of regular skilled captains, and the popularity of these outings was such that an additional boat had often to be called into service to meet the demand.

Judges inspecting narrow boats for award of the "Knill Cup." Reading from right to left, The Earl of Lucan, Mr. John Knill, Mr. Arthur Stokes (winner of cup) and Mrs. Stokes.

Amongst the boats which attracted particular attention were the Executive's magnificent inspection craft, "Kingfisher"; the converted monkey boat, "Beatrice," of the Severn Wild Fowl Trust, brought by Mr. Peter Scott, a vice-president of the Inland Waterways Association; and the boat "Cressy," with her owner, Mr. L. T. C. Rolt, on board. Mr. Rolt is, of course, the well known author of a number of books on canals and other subjects, and a co-founder of the Association. Apart from these well known visitors who travelled by water, the rally was attended by Lord Cromwell, Lord Lieutenant of Leicestershire, Sir Alan P. Herbert, Sir Reginald Hill, chairman of the Docks and Inland Waterways Executive, and Mr. L. Cleaver, harbour engineer, Ministry of Transport.

STATEMENT BY SIR REGINALD HILL

At an interview with the press, Sir Reginald Hill stated that the Executive saw with keen interest the success of the rally and had been pleased to co-operate. He was glad to see the revival of interest in inland navigation and to encourage the use of the waterways by pleasure craft, provided that they did not hamper or interfere with the commercial traffic, to provide for which was the primary duty of the Executive.

Publicising English Canals—continued

Working narrow boats which were used during the Rally for pleasure trips.

In present conditions expenditure was necessarily limited and the rehabilitation of the waterways system must be tackled in a practical way. The first call on available resources must be for those waterways which are commercially used and have prospects of development in that respect. It would be unjustifiable to spend large sums of money on restoring canals which would not be likely to carry traffic commensurate with the expenditure.

The policy of the Executive had been to give priority to the improvement of the standard of maintenance of the commercially used canals by dealing with arrears of dredging, bank protection and boat maintenance. Thus was the traffic capacity of the waterways increased and the carriage upon them made more economical. He mentioned that the Executive had spent more than £200,000 on overtaking maintenance arrears alone — in addition to normal maintenance expenditure.

PRESENTATION OF PRIZES

The week ended on Saturday, the 19th, with a procession of boats along the canal, at the head of which was the Leicester Caledonian Pipe Band, carried in the hold of Mr. Knill's boat "Kenelm," immediately followed by a motor boat carrying the "Waterways Queen," who was elected at the rally, and a further long procession of the winning boats. In the evening the awards were formally presented, and again it was gratifying to those interested in commercial traffic to observe that by far the greatest applause was given to the captains of the working boats.

Part of the procession of prize-winning boats.

Great credit is due to all those responsible for organising this event, and particularly to those members of the Market Harborough Urban District Council who were responsible for the provision of the facilities for such large numbers of people. In this connection, particular mention should be made of Councillor C. M. Allsop, J.P., Mr. J. G. Barlow, M.I.Mun.E., the Council's Surveyor, Mr. B. G. Elliott, M.R.San.I., and Mr. Biddleston, who organised the accommodation register for those people who were unable to travel by boat and therefore were accommodated ashore.

Of equal value was the co-operation of the Docks and Inland Waterways Executive, who had allowed a very considerable concession in halving the normal charges for pleasure craft visiting the rally. Furthermore the Executive's staff, under the control of Mr. A. J. Finnegan, District Engineer, made notable efforts, particularly in their vigorous attack upon the weeds along the little used Market Harborough arm, whilst lock keepers all along the route and supervisory staff remained on duty for long hours to assist the large numbers of pleasure boats over the canal.

NEED FOR A DEFINITE POLICY

It is hoped that events such as this will do something to revive interest in the canal system, while there is no doubt that the passage of so many boats, particularly the narrow boats, will have helped to improve the condition of the channel.

Is it too much to expect that this rally will have attracted sufficient attention to the problem of the English canal system as a whole, to result in long term plans for its future being formulated? The case made by Sir H. Osborne Mance, in his address to the Institute of Transport,* calling for an early decision and a statement of policy concerning the narrow canals, remains unanswered. Whilst congratulations are due to captains of pleasure craft for their prowess in working boats, often unsuitable for the peculiar conditions of the English narrow canals, to the rally, and to the captains of trading boats for their skill and restraint when they encountered such pleasure craft, as a result of which no serious accident has been reported, the question of whether pleasure boats can make a measurable contribution, on balance, to the receipts of the English canal system, remains by no means certain.

Port of Cape Town

Need for Improved Facilities

According to the "Cape Argus" the Cape Town Chamber of Commerce has formed a harbour development committee as the first step in a campaign to secure improved facilities at Cape Town docks. The committee, which consists of 29 men who are influential in shipping and trading circles, is to seek the co-operation of all commercial, industrial and shipping organisations with a view to making representations to the Government.

At the inaugural meeting of the committee, Mr. Russell, the convenor, pointed out that the need for approaching the Government was strengthened in view of the statement of the General Manager of Railways that there was no project in view. Mr. Russell suggested that interested bodies and individuals such as Members of Parliament, should be called together to make joint representations to the Government.

Presenting a memorandum dealing with methods of discharging cargo at the docks, he said that much improvement was needed over the present "bucket, shovel and sack" method of discharge for commodities such as wheat, phosphate and coal, and he thought the use of mechanical grabs should be considered. Referring to the fire hazards, he criticised the practice of berthing oil tankers next to other ships, in close proximity to the town, and also urged the need for improved facilities for the reception of passengers.

* See January, 1950, issue of "The Dock & Harbour Authority."

Correspondence

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,

THE PORTS OF MOZAMBIQUE

The editorial article which appears in your August issue under the above heading gives a well-balanced account of the importance of the Mozambique ports and of their past history. The contributed article under the same heading is also of great interest but suffers, if one might be allowed to criticise, from the same defect contained in many recent press articles on the same subject.

The impression one gains from these articles is that the Port of Beira has been happily released from the management of a private company to the enjoyment of great expansion made possible by Government ownership. This hardly represents the facts and does less than justice to the energy and enterprise displayed by the Company which, during a quarter of a century's operations, transformed a hopeless looking mud flat into a well-equipped modern port fully capable of dealing with all the traffic it was called upon to handle.

Congestion is not a new problem at the Port of Beira, which has been caught, in the past, in common with other ports, by the fluctuations of trade booms and depressions, but each boom was accompanied by appropriate expansion and the Companies which provided the capital paid the penalty in the succeeding years of depression.

The last major extensions were completed at the beginning of the war, but for the war and the expiry of the Company's concession, there is no doubt that the already planned extensions would by now have been completed and in full use. It is open to question, therefore, whether " it was fortunate that certain charters and concessions held by various Companies in Mozambique expired during the last few years."

I am sure that the author of the article intended no criticism of the British Company but it seems only fair to the Company and to British enterprise that the great part both have played in the development of this previously backward and neglected port should be properly known. Memories are short and few will remember the shaking of heads in Beira when British engineers, undeterred by two previous wharf failures, arrived to pull down their remnants to make way for new deep water wharves on the mud banks of the Pungue. It may have been forgotten, too, that when the first berth had been successfully constructed, the regular liners fought a long (though losing) battle against " coming alongside " with the strong currents of the river to contend with. Yet in a few years' time the same liners fought an equally gallant battle for the privilege of being first in the queue for a berth at the self-same wharf.

It is easy to follow where others have succeeded but it requires faith and courage to succeed where a record of failures already exists, and all too little has been said in the past of the enterprise which, in the face of great natural difficulties, has established Beira in its present position as the fourth port of Southern Africa.

The Portuguese administration of ports and railways in East Africa is an enlightened and progressive one and can be trusted to continue the development of Beira with energy, but let honour be given where it is due—to the Companies which undertook the original and hazardous pioneer work and showed that a port could be built on the banks of the Pungue.

I regret the necessity of signing myself anonymously,

London. Yours faithfully,
10.8.50. CHIVEVE.

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,

SPANISH FORMULAE FOR RUBBLE MOUND BREAKWATERS AND SEA WALLS.

I would be pleased if you could find space in your next issue to correct an error which I failed to detect when reading the proofs of the above, published in the August issue of " The Dock & Harbour Authority."

The expression (3) at the head of the second column, p. 126, should read:—

$$i = 8/T \sqrt{h/2g} \qquad (3)$$

where i = tangent of slope = vertical depth/horizontal distance.

The *horizontal distance* is measured from zero depth on the still water line to the point where the change of slope takes place at a *vertical depth* below still water line.

Yours faithfully,
Bath, Somerset. R. R. M.
15 : 8 : 50.

OIL DISCHARGED IN BULK AT DAR-ES-SALAAM.

A report from Tanganyika says that for the first time a tanker has discharged her cargo at Dar-es-Salaam in bulk. She was the *Moccasin Gap*, which brought petrol, gas oil and kerosene from the Persian Gulf. The oil was pumped through a floating pipeline, but later on it is hoped the oil companies will have an independent wharf. Shore installations at this port will eliminate much of the small steamer trade from Mombasa to the south.

TYNE IMPROVEMENT COMMISSION CENTENARY.

The Tyne Improvement Commission will celebrate its centenary on September 20 with a Thanksgiving Service in Newcastle Cathedral. This will be followed by an inspection of the river and a luncheon at the Old Assembly Rooms, Newcastle. Several prominent personalities are expected to be among the 300 guests invited, and to accommodate them on the inspections of the Tyne the ferryboat *Northumbrian* will be withdrawn from her usual run.

APPOINTMENTS.

THE DOCKS AND INLAND WATERWAYS EXECUTIVE, 22, Dorset Square, London, N.W.1, invite applications for the post of Mechanical Engineer, South Wales Docks. Applicants should have corporate membership of the Institution of Mechanical Engineers and have sound general and electrical engineering experience.

The starting salary will be £1,400/£1,600 per annum, according to qualifications and experience.

The person appointed will be expected, if eligible, to join a contributory superannuation scheme and in this respect to comply with whatever provisions are decided upon later for the Executive's staff as a whole.

Applications, giving full details of qualifications and experience, should be sent to the Secretary, at the above address, to arrive not later than 16th September, 1950.

ASSISTANT TO DOCK SUPERINTENDENT required by large undertaking with wharves and jetties on River Thames. Must be capable of supervising loading and unloading of ships and handling of bulk and liquid cargoes.

The applicant must have engineering training and be familiar with the plant used in connection with this work. Experience of the Dock Labour Scheme an advantage. Age: 30-35.

Salary £650-£800, according to qualifications. Send particulars and qualifications, etc., to Box No. 116, " The Dock & Harbour Authority," 19, Harcourt Street, London, W.1.

FOR SALE.

125 TON FIXED ELECTRIC HAMMERHEAD CRANE.

An exceptional opportunity occurs to acquire a modern heavy lift Hammerhead Crane, which is at present being constructed by Messrs. Stothert & Pitt, Ltd., Bath. Owing to a change in policy, this Crane, ordered in 1948, is no longer required. Delivery of the Crane is promised by the makers to commence towards the end of 1950 and to be completed early in 1951.

Specification of Crane:

Maximum working load at 80-ft. 0-in. radius	125 tons.
Maximum working load at 135-ft. 0-in. radius	20 tons.
Height of lift above Quay level	100-ft. 0-in.
Depth of lower below Quay level	30-ft. 0-in.
Centres of tower legs across Quay	30-ft. 0-in.
Centres of tower legs along Quay	28-ft. 6-in.
Height of Tower	90-ft. 0-in.
Weight of tail ballast (not included) approximately	125 tons.
Estimated weight of crane, including ballast	850 tons.
Maximum corner load on foundation, approximately	430 tons.

For details apply to Sir Alexander Gibb & Partners, Consulting Engineers, Queen Anne's Lodge, Westminster, London, S.W.1.

SEVERAL UNUSED 6-TON STOTHERT & PITT ELECTRIC PORTAL CRANES, 63-ft. centre jibs, 60-ft. max. radius. Power travelling, 15-ft. rail gauge. 86 h.p. 460-480 v. D.C. motors driving 57 k.w. generator supplying 220 v. D.C. to crane motors. Generator mounted in special housing on portal frame. George Cohen Sons & Co., Ltd., Wood Lane, London, W.12. (Tel.: SHE 2070.)